1895.

WESTERN AUSTRALIA.

REPORT

ON THE

DEPARTMENT OF MINES

FOR THE YEAR

1894.

Presented to both Houses of Parliament by His Excellency's Command.

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1895.

No. 16.

DEPARTMENT OF MINES.

Report on the Department of Mines for the Year 1894.

To the Honourable E. H. Wittenoom, M.L.C., Minister for Mines.

Department of Mines,
1st August, 1895.

SIR,

I have the honour to submit my Report upon the working of the Department of Mines and the progress of mining in this Colony during the year 1894, together with the results therefrom, which were partly included in the *ad interim* Report furnished by me for the six months previous to the session of Parliament in that year, at the request of the Honourable the Commissioner of Crown Lands, under the control of whom the department then lay.

The following table will inform you of the clerical work performed at the Head Office of the Department, irrespective of the work performed in the offices of the seven Wardens of the Goldfields, which had been proclaimed before or during the year, and that of the Mining Registrar at the Greenbushes Tinfield:—

Papers registered	3027
Letters written	2750
Applications received	1986
Leases approved	1284
Area held under approved lease, 31-12-94 (*see* Table 2) ...	13,841
Leases issued	113
Transfers registered	1624
Plans compiled (*see* Appendix)	14

The above work was performed by the following officers:—

H. C. PRINSEP	Under Secretary,
L. L. CROCKETT	Chief Clerk,
J. F. ROE	Accountant,
A. H. BARLEE	Chief Draftsman,
J. J. HIGGINS	Inspecting Draftsman,
F. M. WILLIAMS	Assistant Draftsman,
G. HORGAN...	Clerk.

The number of Leases surveyed was 1046.

The number of diagrams of survey of same, which were checked, was 601.

In the Drafting Department, during the year, Lithographs were published of all Mining Centres where a number of leases had been taken up and surveyed. These Lithographs had continually to be corrected and kept up to date, according to the number of forfeitures and new leases, and, in some cases, as many as ten new editions of the same Lithograph were published (the additions and corrections having to be made on the stone). Besides the Lithographs published for sale by the Department, seventeen illustrations and geological plans were drawn and lithographed for the reports of Mr. H. P. Woodward and Mr. S. Göczel.

More than 30 rough Compilation Progress Sheets were drawn, on which all the diagrams of surveyed leases were charted, and these had to be kept up to date as the diagrams came in.

Books of reference are kept showing immediately on what sheet leases are to be found. Record Books of Lithographs, of Compilation Sheets, and of Stones, &c., are also kept.

Several Compass Traverses were plotted from Explorers' rough Field-Books; numerous tracings were also made, and much work necessary for the working of the Department, other than what is here detailed, was done.

Plans were despatched, regularly, to Wardens and other Officials on the Goldfields, and to many persons and societies on the free list, both within and without the Colony.

List of Lithograph Plans for sale during the year 1894.

Route Map to Yilgarn and Coolgardie, &c.
Coolgardie Leases and Townsite.
Mount Burges Leases.
Twenty-five-Mile Leases.
Ninety-Mile Leases and Townsite.
Kalgoorlie Leases and Townsite.
White Feather Leases and Townsite.
Route Map to Murchison Goldfield.
Cue and Day Dawn Leases, and Townsite.
Nannine Leases and Townsite.
West Mount Magnet Leases and Townsite.
Cuddingwarra Leases and Townsite.
Route Map to Pilbarra.

The offices in which all the work was carried out consisted of two rooms only, but at the close of the year four more rooms were placed at my disposal.

The Goldfields existing at the commencement of the year were as follows :—

Goldfield.		Area.		Proclaimed.
Kimberley	...	47,000 square miles	...	May, 1886.
Pilbarra...	...	32,000 ditto	...	July, 1889.
Ashburton	...	8,200 ditto	...	December, 1890.
Murchison	...	32,000 ditto	...	September, 1891.
Yilgarn ...	...	57,000 ditto	...	November, 1888.
Dundas ...	...	2,400 ditto		August, 1893.

During the year changes and additions were made, as follows :—

New Goldfields.	Area.	Declared.	Remarks.
	Square Miles.		
Coolgardie ...	21,500	6th April, 1894 ...	Including portion of Yilgarn.
East Coolgardie	44,200	21st January, 1894	Eastern portion of Coolgardie.
Yilgarn ...	24,000	6th April, 1894 ...	Enlarged and re-proclaimed.
Dundas ...	16,000	6th April, 1894 ...	Enlarged and re-proclaimed.

by which alterations in the area of some of the original Goldfields were made, and at the end of the year the Goldfields in existence were as follows :—

	Square Miles.		Square Miles.
Kimberley	47,000	Yilgarn	24,000
Pilbarra	32,000	Coolgardie	21,500
Ashburton	8,200	East Coolgardie... ...	44,200
Murchison	32,000	Dundas	16,000

Some important changes in the Regulations were made during the year, by the amendment of Clauses 5 and 60, the first of which facilitated operations under a Miner's Right by abolishing the necessity of counter signature by the Warden of any Goldfield to which the holder migrated, and the latter regulated more precisely than before the process of Application for Leases and their subsequent survey; and by the promulgation of new Regulations 60*a* and 62*a*, the former limiting the period for application after pegging for lease, and the latter reducing the Survey Fees of blocks previously surveyed for other holders and relinquished.

Early in the year it became apparent that both the Act and Regulations required many modifications and additions, to meet the peculiar conditions of our Goldfields; I, therefore, with the assent of the Minister, solicited suggestions from the mining community by issuing a large number of circulars, which were responded to liberally, and on the appointment of a Committee by the Legislature, I laid before them a draft Bill, embodying the suggested changes which appeared immediately necessary. The Committee did not do much, owing to the pressure of other public business, and a short Bill was then drafted by the Hon. the Attorney General, which was passed by Parliament and assented to in November. The particular points dealt with by this Act (viz: 58 Vic., No. 28) were the conditions under which leases should be granted, amending Section 10 of the main Act by giving certain privileges to alluvial miners on land applied for as leases; the division of Goldfields into districts, and jurisdiction of District Wardens' Courts; and lastly, the validation of all previous action under the Regulations, so as to set at rest questions which had been raised on these points where they were not clear. The bulk of the suggestions I had collected together were afterwards added to the notes taken at a Conference of Wardens convened by you on taking office, with the view of the drafting of a new and more comprehensive Bill for consideration of Parliament during its Session of 1895.

The importance of our Goldfields, and the brilliant prospect of gain thereon, had spread not only to the neighbouring colonies, but to Europe and other parts of the world, and a great influx of population was the result, which, first collecting at the recognised mining centres, and then spreading to the unexplored country around, caused the discovery of new auriferous localities to become a matter of weekly, and even daily, occurrence. Among these were some specially remarkable which attracted much attention and capital to the Colony, such as the Londonderry, the Wealth of Nations, the Norseman, Peake's Find, and others. It is stated that in 1894 there were not less than 100 Western Australian mining ventures registered in London, with a nominal capital of £8,415,000. A list is given (see Table 1) of the 70 Mining Companies registered in the Colony.

The Mining Revenue for 1894 was £31,608 7s. 9d. (Table 5 gives details). Throughout the year, however, mining operations, more especially on the Eastern Goldfields, were much retarded by the great scarcity of water, and it was not until December that the long drought was broken. The Department of Public Works undertook the heavy duty of keeping the main roads open, and constructed a number of Reservoirs to receive the surface drainage from some of the bald granite outcrops, which are a peculiar feature in many districts.

In December I proceeded to the Eastern Goldfields, on a short tour, to inspect the work of the Registrars' Offices thereon, and to ensure uniformity in their management. By the kindness of Messrs.

Mercer and Hooper (the latter of whom was my courteous cicerone) the trip was a speedy and comfortable one, and I was enabled to visit Southern Cross, Coolgardie, Kalgoorlie, and Kanowna, and to make myself conversant with many matters on which only a personal observation could enlighten me; *inter alia*, the general appearance of the country, the qualities of the auriferous rocks, the modes of mining, and mining parlance, the treatment of the ores, the water difficulties, &c.; as well as becoming personally acquainted with the officers, and many of the leading men in the community, and obtaining their opinions as to the Regulations, their advantages and defects, and the way in which they were carried out. I was able to descend and view the following mines:—McAuliffe's Reward, at White Feather; Lake View and Great Boulder, near Kalgoorlie; and Bayley's Reward, at Coolgardie; and also to go through several of the underground galleries in the cement deposit at Kanowna. I also went over the upper works of several other mines, visited the Six-mile alluvial diggings south of Kalgoorlie, and saw Hannan's Lake, and was thus enabled to form a good idea of the future water supply there and the general prospects; and from what I saw on the small portion of the great auriferous region that I had the advantage of crossing, I came back with a far more confident opinion of the great future these fields must have before them when the means of locomotion are improved. The busy streets and crowded warehouses of Coolgardie, and the beaten roads spreading out from it in all directions, tell a wonderful tale of British energy, perseverance, and courage. I have no doubt that this trip, which cost a very small sum to the Government, has been of great service to me in my conduct of the Department. On my return to Perth I found that it had been made a principal Department, of which you had been appointed the Minister.

Geological.

The Government Geologist (Mr. H. P. Woodward) has forwarded a Report of the work of his branch during the year. (*See* Appendix 1).

Mr. S. Göczel was also employed during the year as Assistant Government Geologist. His first duties were to prepare the report of his expedition south-east from Coolgardie, in 1893, which was attached to my *ad interim* Report previously alluded to. He was then, for a short time, employed classifying geological specimens in the Museum, and in April was sent out for a six months' expedition from Coolgardie northwards to Cue, and through a portion of the Murchison Goldfield. His interesting report, prepared on his return, with plans and sketches, is attached; and I regret that circumstances have prevented its previous issue. (*See* Appendix 3).

With regard to the work of the Geological Branch, reported on by the Government Geologist, in alluding to his previous Report of June, 1894, on the Collie River Coal Basin, it appears proved that his map and his prediction of a large Coal Basin there have been corroborated by subsequent discoveries. It is also a matter for congratulation that the bore, which was put down near the Midland Junction by the Public Works Department, upon his advice against all previous opinions, struck an artesian supply of water.

Museum.

At the Museum a great number of additional exhibits were collected. A taxidermist was employed for many months collecting and preparing small birds and animals in the southern portion of the Colony, and an assistant was occasionally employed. The latter was sent to Houtman's Abrolhos, where he succeeded in obtaining a number of rare and beautiful specimens of sea birds, in which assistance was rendered by Mr. Broadhurst. A large collection of fish was also presented to the Museum by Mr. Saville Kent.

Assays.

The number of assays made at the Laboratory amounted to 248. The Government Assayer's Report is attached (*see* Appendix 3).

I have prepared diagrams to show the proportionate amount of gold yielded by the several gold-fields in 1894, and the proportionate increase in the annual yield of gold in the whole Colony, from 1886 to the end of 1894, the four columns in each year's space representing the quarterly returns; by these the progress in the gold-mining industry will be seen at a glance. (*See* diagrams 1 and 2).

In the absence of any official report as to machinery at work on the fields, I have carefully searched the reports in the press, and gather that the amount during the year was, approximately, as follows:—

Murchison Goldfield ...	15 Batteries	4 Otis Mills ...	2 Huntingdon Mills.
Pilbarra ,, ...	7 ,,	...	...
Kimberley ,, ...	4 ,,	...	...
East Coolgardie ,, ...	5 ,,	2 Otis Mills ...	1 Krom Roller Mill.
Coolgardie ,, ...	8 ,,	3 Panklast Crushers	1 Krupp Ball Mill.
Yilgarn ,, ...	5 ,,	...	...
		...	...

Arrangements will be made to secure, in the future, accurate information of the amount of machinery of all kinds on the goldfields, so as to show the rate of progress.

I have, &c.,

HENRY C. PRINSEP,
Under Secretary for Mines.

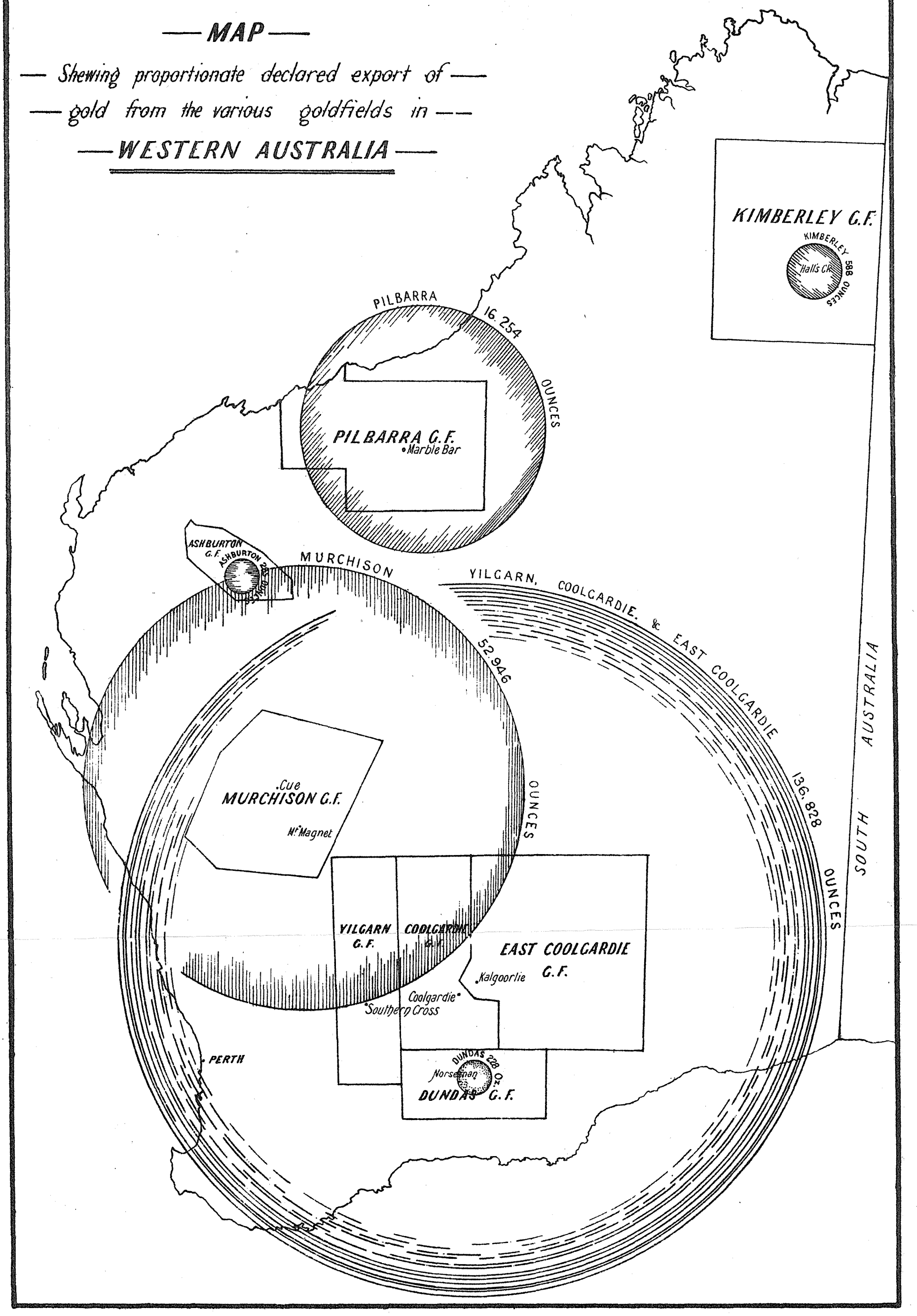
Table 1.

	Shares.		Amount.
Ballyvaughan Gold Mining Co., No Liability	32,000	at	1s. 3d.
Wauchope & Fartiere Dry Blowing, Pulverising, and Amalgamating Co., Limited	120	,,	£10
Mount Prophecy Gold Mining Co., No Liability	60,000	,,	£1
Annesfield Prospecting and Mining Co., Limited	750	,,	£15
Queensberry United Gold Mining Co., No Liability ...	1,250	,,	£1
Bunbury Prospecting Association, Limited	400	,,	£1
The Lone Hand Gold Mining Co., No Liability	56,000	,,	£1
New Chum South, No Liability	60,000	,,	10s.
Nil Desperandum Gold Mining Co., No Liability	6,000	,,	£1
Glanmire Gold Mining Syndicate, No Liability	600	,,	£5
Westralian Prospecting Association, No Liability	200	,,	£5
Great Dundas Gold Mining Syndicate, Limited	150	,,	£10
Pluck Up Gold Mining Co., No Liability	1,500	,,	£1
Bayley's No. 2 South Gold Mining Co., No Liability ...	160	,,	£50
Big Blow Gold Mining Company, No Liability	2,200	,,	£2
Coolgardie South Gold Mining Co., No Liability	80	,,	£10
The Lake Lefroy Gold Mining Co., No Liability	800	,,	£5
Cue 1 Proprietary Gold Mining Co., No Liability	60,000	,,	10s.
Balharry Reward Gold Mining Co.			
Mawson's Reward Claim, Limited			
South Day Dawn Co., No Liability			
The Grant & Lempriere W.A. Prospecting Association, No Liability			
The Victory United Gold Mining Co., No Liability			
The Golconda Gold Mines, Limited			
Murchison Proprietary Co., No Liability			
Morning Star Quartz Co., No Liability			
Mallina Gold Mine, Limited			
The Success (Western Australia) Prospecting and Mining Co., Limited			
New Prince Gold Mine Co., No Liability			
Aurora Prospecting Co., No Liability			
W. A. Prospecting Syndicate, Limited			
Cue Victory Gold Mining Co., No Liability			
White Feather Reward Claim, Limited			
Coolgardie Gold Mining Co., Limited			
Friendship Gold Mining Co., No Liability			
Xmas Extended Gold Mining Co., No Liability			
Napier Syndicate, No Liability			
Bissenberger Gold Mining Co., Limited			
Blackett's Claim Gold Mining Co., Limited			
Londonderry Confederation Co., Limited			
Kinsella Gold Mines, Limited			
Crœsus Gold Mining Co., No Liability			
Murchison Consolidated Gold Mining No Liability			
Premier Gold Mining Co., No Liability			
Fortune of War Gold Mining Co., No Liability			
Bayley's Consols Gold Mining Co., No Liability			
Ivanhoe Gold Mining Co., No Liability			
Lake View and Boulder East Gold Mining Co., No Liability			
Kangaroo Gold Mining Co., No Liability			
Lindsay's Gold Mining Co., No Liability			
Tindal's Coolgardie Gold Mining Co., No Liability			
Bayley's Reward No. 3 South Gold Mining Co., No Liability			
Austin Gold Mining Co., No Liability			
Bendigo and Coolgardie Proprietary Co., No Liability			
Bayley's Reward Claim Gold Mining Co., Limited			
Maritana Gold Mining Co., No Liability			
Kurnalpi Proprietary and Prospecting Co., No Liability			
Hannan's Hill Gold Mining Co., No Liability			
The Jesson and Hadfield Prospecting and Mining Co., No Liability			
W.A. Goldfields, Limited			
Bayley's South Extended Gold Mining Co., No Liability			
W.A. Day Dawn Gold Mining Association, Limited			
The Trenton Gold Mining Co., No Liability			
Mount Burges Gold Mining Co., No Liability			
St. George's Proprietary Gold Mining Co., No Liability			
Lefroy Coolgardie Gold Mining and Prospecting Co., Limited			
Francis Reward Gold Mining Co., No Liability			
Pearce Gold Mining Co., No Liability			
Garden Gully Gold Mining Co., No Liability			
Thornett's Red Hill Lady Lily Gold Mining Co., No Liability			

No. of shares and amounts not given.

— MAP —

— Shewing proportionate declared export of —
— gold from the various goldfields in —
— WESTERN AUSTRALIA —



— Diagram shewing annual export —

— OF GOLD —

— W. A. —

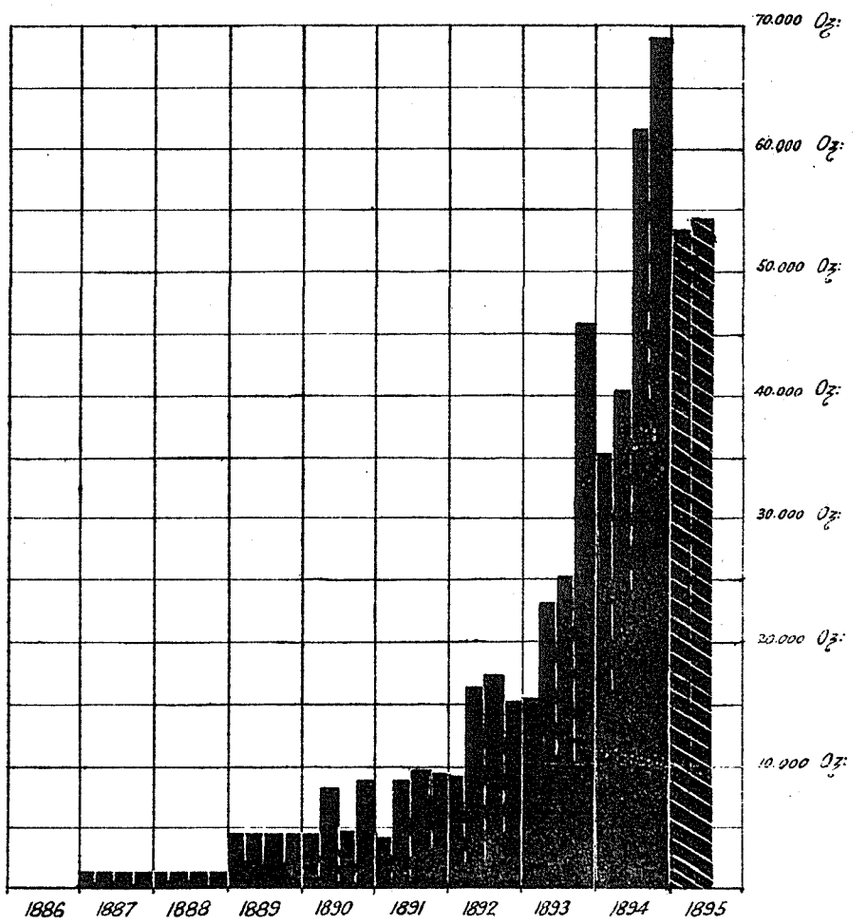


Table 2.

Area held under Lease (approved) on 31-12-94.

Goldfield.	Area in acres.
Coolgardie	5697
East Coolgardie	4032
Murchison (including Yalgoo)	2817
Pilbarra	569
Yilgarn	453
Dundas	252
Kimberley	21
Total	13841

Table 3.

Miners' Rights and Mining Licenses, issued in 1894.

Issued at		Miners' Rights.	Mining Licenses.
Coolgardie—Coolgardie	7091	7459	0
Goongarrie	33		
Kalgoorlie and Kurnalpi ...	335		
Murchison—Cue	1936	2090	3
Nannine	52		
Mt. Magnet	23		
Yalgoo	79		
Pilbarra		415	4
Yilgarn		595	0
Dundas		241	0
Kimberley		63	0
Geraldton		185	9
Albany		158	2
Roebourne		36	24
Carnarvon		10	0
Greenbushes (Tin-field)		0	102
		11252	144

Table 4.

Table of Deaths reported on the Goldfields.

Goldfields.	Disease.	Drought or starvation.	Suicide.	Mining Accidents.	Total.
Kimberley ...	...	...	1	...	1
Pilbarra ...	2	...	...	...	2
Ashburton ...	...	...	...	...	...
Murchison ...	43	1	1	1	46
Yilgarn	87	2	2	3	94
Coolgardie ...					
Dundas	...	...	...	...	...
	132	3	4	4	143

N.B.—It is feared that some deaths, by drought or starvation, were not reported. Compared to the population, the percentage of deaths is low.

Table 5.

Mining Revenue for 1894.

Received at	Amount. £	s.	d.
Kimberley	143	14	0
Pilbarra	1048	6	0
Murchison	6090	1	6
Yilgarn	967	5	6
Coolgardie	20611	15	0
East Coolgardie*	746	9	0
Dundas	822	17	6
Greenbushes...	111	5	6
All other places	1066	11	6
	31608	5	6

* Established in August only as a separate office.

Appendix 1.

ANNUAL REPORT FOR 1894.

BY THE GOVERNMENT GEOLOGIST.

In January, 1894, I returned to Perth from the Dundas goldfields, where I had been acting as Warden for the preceding four months.

The first work which engaged my attention upon my return was the preparation of a report upon the field and the country passed over on my journey there. This report was published in the *ad interim* Report of the Department of Mines for the half-year ending 30th June, 1894.

Accumulated correspondence, notices of the Colony for the various Year Books, our own "Year Book," and my first edition of "The Miners' Handbook," occupied my time until April, when I started for the Collie coalfield, the boundaries of which I mapped in reporting upon the whole area. This Report also was published in the *ad interim* Report.

Later on I prepared another special report and map of the Collie coalfield area, with a tabulated diagram of the sections obtained in the bore-holes, for the information of Parliament.

The next piece of work undertaken was the Greenbushes tinfield, which I mapped and reported upon, this also being published in the *ad interim* Report.

Shortly after the completion of this piece of work I was instructed to sign, on behalf of the Government, a contract with Mr. Atkinson for diamond drill boring upon the Collie coalfield. This contract was to bore 1,800ft. at such sites as I should select. The fixing of these sites and superintending this work occupied a great deal of time, and was so much a tie that towards the end of the year I appointed a supervisor to be always on the spot to take charge of all cores, measure casing, and measure up and give certificates for all work done.

Until this appointment was made I had made short trips about the country between the Bunbury and Albany Roads, and upon one occasion managed to get as far South as the Margaret River, upon the Augusta Road. However, upon being relieved, I started for the South Coast, which I examined from Lake Muir to Deep River Inlet, and Westward to Point D'Entrecasteaux, returning up the Warren, the Tone, and across to the Balgarrup River.

Since a report upon most of my last year's work has already been published, it only remains for me to give a short description of the country in the South-West portion of the Colony that I had time to partially examine. This work, I may mention here, was undertaken with the idea of determining whether other patches of coal-bearing country existed, and this, unfortunately, has proved not to be the case to the Southward; our only hope, therefore, lies in the belt of country on the Eastern slope of the Darling Ranges, Northwards of the Collie, and between it and the Murray River. It is true, of course, that we have deposits of more recent coals upon the South Coast, and that a large coastal plain, beneath which there may be true coal measures, extends some distance South of the Vasse River, but as there are no surface indications no opinion can be given upon this subject, which can only be set at rest by deep boring.

The full report upon the Collie coalfield must be held over until the completion of the contract.*

HARRY P. WOODWARD.

9-2-95.

[Enclosure to Appendix I.]

THE SOUTH-WESTERN PORTION OF THE COLONY.

Between Capes Naturaliste and Leeuwin, running in a north and south direction, is a low ridge of granite, capped in many places by recent deposits of limestone, which the subterranean water has riddled with caverns, many of which are very extensive, and magnificently decorated with stalactites and moss-like encrustations of carbonate of lime.

Along this line of coast the granite outcrops upon the beach, and it is due to the protecting influence exercised by it that this small promontory exists.

Copper is reported to have been found upon the beach a little south of Cape Naturaliste, but it is probably a mistake, as the rocks are not of a promising appearance, and no signs of mineral veins are to be met with.

Directly to the eastward of this range of hills the country is low for a distance of about 25 miles, the plain being generally covered with sand, except where the Blackwood River has cut its way across it, exposing the underlying crystalline rocks in its bed. This tract of low, sandy country extends northward, following the coast lying between it and the bold Darling Ranges. In this northern portion these flats are often intersected by large marshes or inlets, into which the rivers discharge themselves, whilst along the sea shore high sand dunes are generally met with, the only other formation exposed being the basalt dyke which outcrops and forms the small point at the mouth of the Leschenault Inlet, upon which Bunbury stands.

Beneath this flat, both in the Preston Valley, near Bunbury, also near the Vasse, some deposits of fossil wood were discovered, which encouraged the residents of the former to sink some trial holes, and those of the latter to get

* This is now attached. See Appendix 2.

the Government to test it for them with a drill, the idea, of course, being that there were indications of coal, which, however, is not the case yet; at the same time it is impossible for anyone to say that true coal measures do not exist beneath these recent surface beds, and this matter can only be set at rest by sinking bore holes until older rocks than the carboniferous are met with.

A mesozoic coal deposit was discovered some years ago upon the Fly Brook, a branch of the Donnelly River, on the South Coast, and it was tested by several bore holes, from which, however, the coal did not prove to be of a good enough quality to pay working expenses. [For fuller particulars upon Fly Brook coalfield see Mining Handbook.] Coal and kerosene shale are reported to have been discovered on the western side of this plain, near the Chapman River, a tributary of the Blackwood River, whilst a great quantity of bitumen is washed up all along the south coast, particularly on the sandy bay-like portion between Cape Leeuwin and Point D'Entrecasteaux.

On the eastern side of this belt of low-lying country is a steep escarpment, formed by the outcrop of the crystalline rocks called the Darling Range, along whose base quartz reefs outcrop, which generally contain large quantities of pyrites, and are sometimes auriferous. In comparatively modern times this range presented a bold cliff-like face to the sea, which at that period washed its base; but since the elevation of the land, this precipitous face has, in a great measure, been weathered away or covered by the accumulating "talus." This range may be said to extend for a distance of about 160 miles in a northerly direction from the Blackwood River, where it really terminates, although the same line is continued by more or less low broken ridges south to the Warren River. The termination of this range is due to the change in strike of the rocks from north and south to east and west, to which is also due the change of the direction of the coast line.

In these ranges, for the most part the soil is very good on the small alluvial flats, also in some places on the hill sides; but unfortunately it is, as a rule, limited in extent and heavily timbered, whilst the steep rough hills, covered with conglomerate, render carting very expensive. In this line of country, near Bridgetown, the Greenbushes tinfield is situated (for full report see *ad interim* report of Department of Mines, June, 1894), not very far from which some very fair samples of mica were found, whilst a few miles south, at the head of the Donnelly River, where the formation makes its turn to the eastward, some very large beds of a poor graphite have been tested.

Some years ago a deposit of graphite (plumbago) was discovered near the head of the Donnelly River, about 10 miles east of Dicksons' on the Lower Blackwood Road, and between eight and ten miles south of Nelson Grange, the property of Mr. Allnutt, a few miles from Bridgetown.

About six years ago a syndicate was formed at the Vasse, which took up and prospected several blocks, but the price of graphite at the time was so low that the work was abandoned before much had been done.

Early in the year 1894 Mr. A. Knox Brown reported that he had discovered apparently payable plumbago on a protection area which he had taken up near the older find. This latest discovery is situated between two creeks which flow in deep valleys, from one of which a drive to the north has been put into the side of the ridge at right angles to the outcrop of the deposit, with the result that three beds were passed through. The first of these, which outcrops near the mouth of the drive, is 28ft. in thickness, being followed by 13ft. of schistose rock, containing a small bed 1ft. 6in. in thickness, whilst the third bed is 8ft. in thickness.

Several other shafts have been sunk, and open cuttings made to test the run of these beds. From one of the former, about four chains to the westward of the drive, which appears to be upon the large bed, a sample, weighing 25cwt., was sent to England in order to ascertain its commercial value. In another shaft, about 15 chains further up the spur to the westward, at an elevation of about 100ft. above the mouth of the drive, the deposit was again struck at a few feet from the surface.

These beds should, correctly speaking, be called plumbaginous schists, since the percentage of graphite contained is so small, the main portion of the deposit consisting of a magnesia silicate. The formation consists principally of micaceous and talcose schists, which here strike east and west, dipping at a high angle to the northwards; whilst following along to the southward, close to the outcrop of the graphite beds, is a large dyke of intrusive granite.

A little to the eastward of the drive, at the junction of the two creeks, the outcrop of this deposit is lost, but beds of steatites are met with along this line as far as Wilgarup; therefore the graphite seams will also probably be found to extend in this direction, the local break in the continuity of the rocks being due in all probability to a fault. To the westward the graphite can be traced for several miles, but the beds seem to split up and become smaller upon the claims that were first prospected.

This deposit of earthy graphite is due to the alteration of poor shaley coal seams, because the formation does not consist of veins, but true beds, the metamorphosis being in all probability due to the indurated granite to the southward, which changed the coal seams into graphite, and the shales into schists. It offers exceptional facilities for cheap working, since the spur upon which it is situated rises so rapidly that a drive following the strike from the outcrop in the creek would have 100ft. of backs in a distance of about 20 chains; whilst, if crosscuts were driven about five chains from the valley which runs parallel to the strike, the seam would be obtained.

The firm of crucible makers to whom the sample was sent reported it to be of no commercial value, but since graphite is put to a multitude of uses at the present day, in most of which forms it is largely adulterated with earthy matter, and so long as our deposit does not contain any deleterious substance, it should certainly be of some value.

When we consider the large size of the deposit, the cheapness with which it could be worked, its short distance from good roads, the enormous quanity of karri timber on the spot of almost any length, and the perpetual supply of running water, it should certainly, if not at present, prove in the near future to be of great value.

Along the bold, rough south coast between Albany and Point D'Entrecasteaux, without shelter or harbours for even small vessels, stretches a narrow strip of calcareous country covered with abundance of herbage. This coast consists of bold headlands of granite or high cliffs of sandstone, which latter, when they form capes, are always protected to a certain extent from the action of the sea by reefs or islands of rock.

There are numerous inlets along this coast, but these are useless as harbours, as they are either too shallow or have their mouths barred, whilst the running streams which discharge themselves into them are gradually filling them up with mud. These inlets were at no very remote period permanently connected with the sea by wide and deep channels, but as the coast rose the sand dunes which now form the cliffs were blown up, fringing the coast between the inlets and the sea, often completely blocking up their entrances.

The only good harbour upon this coast is at Albany, where the natural features have protected its entrance from being closed up by sand. It is, however, being rapidly filled in at the head of Princess Royal Harbour by a sand drift, which is gradually creeping over the coastal hills. When this line of hills was first formed they were more continuous than they are now, but, at the same time, they were lower, whilst behind them was a low, swampy flat or lagoon, into which the streams from the north discharged themselves. In this lagoon accumulated large quantities of vegetable matter, which gradually formed a peaty substance of the brown coal class. This coal is found to be of better quality in the middle of these basins, whilst towards the edges it consists almost entirely of sand; it is also overlaid by black sand, which contains a very large quantity of vegetable matter.

Whilst the coast was still rising, these lagoons were gradually raised to some height above the sea level, until the impounded waters behind the sand hills acquired sufficient force to burst a passage through them, forming openings, which are, in all probability, in many instances the present mouths. Drift sand has been, and is, continually blowing inland, filling up valleys and burying these swampy deposits, thus the original long lagoon has been divided up into the present inlets, which either owe their existence to the fact that they were deeper, or were more sheltered

from the sand drifts. Most of these inlets are very shallow, it being possible for a man to walk quite across Broke Inlet, where it is several miles in width. The reason these inlets are silting up so rapidly is that upon this coast the rise and fall of the tide is too slight to cause a scour.

In patches along this coast limestones of a more or less sandy nature occur, being due to deposits of shelly matter, which were thrown up at the same period as the sand hills.

From time to time great excitement is caused by the supposed discovery of coal, but it invariably turns out to be nothing but the brown boggy lake formation mentioned above. This brown coal occurs in seams often of considerable size, with underlying shale beds, which contain roots and pieces of wood, with pyrites, which latter is often found to have decomposed, forming red ironstone nodules and alum, this latter being met with as efflorescences on the cliff faces. Above these coal beds are sandstones, often containing large quantities of carbonaceous matter, whilst the coal itself varies very greatly in quality, often consisting largely of sand. There are no indications of true coal upon this coast, in fact the granite basins seem to be filled entirely with these recent lacustrine and estuarine deposits, for, wherever rock crops out, these formations are found mostly to rest directly upon it, and when they do not they are only separated by accumulations of clayey matter resulting from the decomposition of the granites, similar to the deposits met with around Albany, even high up the hills.

Most of these ancient basins are small, but even where large ones occur, as to the northward of Albany, there are no indications which would lead one to hold out the least hope that true coal will ever be found here, as brown coal, associated with sandstone shales and iron pyrites, are no indication that the carboniferous formation exists, as these same rocks occur in many different modern formations.

Behind these coastal plains and sand hills the country gradually rises, being heavily timbered in belts with karri forests and thickets of dense scrub, interspersed with which are open sandy plains and swamps, with here and there outcrops of granite.

This belt of country, which is from 20 to 30 miles in width, extends from Mt. Barker, near Albany, to the Donnelly River, and forms, like the Darling Range, the edge of the inland plain, but, unlike it, rises gradually from the coast. In this, the best watered portion of the colony, the land is extremely good in patches, but little has yet been done to utilise it, owing, as a rule, to its inaccessibility and the tremendous expense that would have to be incurred in clearing the land of timber, which is extremely thick and large.

The remaining section of this portion of the colony to be described is that situated between the Darling Range on the west and the Great Southern Railway on the east, or, roughly, the country which is drained by the Upper Blackwood River with its tributaries, and the small sandy basin of the Collie River, in which the coalfield of that name is situated (for full report see *ad interim* report of Department of Mines, June, 1894).

This tract, as a whole, is fairly level, lightly timbered, and possessing larger tracts of good land free from rock outcrops than any of the agricultural portions of the Colony, added to which it has a good average rainfall, its only drawback being the poison plant, which grows thickly upon it.

HARRY P. WOODWARD,
Government Geologist.

Appendix 2.

To the Honourable the Minister for Mines.

Sir, 16th August, 1895.

I have the honour to hand you with this my final report upon the boring at the Collie Coalfield.

The boring contract is now completed, but as all communication is interrupted by the flooded state of the river, the section of the last 150ft. bored at No. 4 has not yet arrived, and I cannot say when it will, so I have made up my report without it, since it really is of no value for my purpose, which was to prove the area of workable coal seams.

I have, etc.,
HARRY P. WOODWARD,
Government Geologist.

THE COLLIE COALFIELD.

Since publishing my report, a year ago, considerable development has taken place at the mine itself, from which a thousand tons of coal has been raised, and the seam followed down upon the underlay for a distance of 300 or 400 feet, the general dip of which is about one in seven.

An air shaft has also been sunk from the surface vertically to a point about 150ft. from the mouth of the drive, in which the following section is exposed:—

	ft.	in.	
Gravel	3	0	
Ironstone	5	0	
Clay and sandstone	7	0	
Yellow sandstone	6	0	
Dark Bind	2	6	20ft.
Coal	0	2	
Rock Bind	0	9	
Coal	2	10	
Dark Bind	1	3	
Coal	12	6	
Shale	0	3	
Total depth	41	3	

Dip—1 in 6·90, or rather more than 1 in 7.

This section is interesting, since from it we can readily understand why this seam was sometimes supposed to be as much as 22ft. in thickness when passed through with a jumping drill, as all the "Bind" bands (hard shale), and probably underlying shale, might be mistaken for coal.

The Coal, as was to be expected from the deeper workings, is considerably superior to that nearer the surface, being a compact, splinty, bituminous coal of the non-caking class.

The following list of assays, with table comparing it with average samples of commercial coals from the other Colonies, will give an approximate idea of its value:—

ASSAYS OF COAL FROM THE COLLIE COALFIELD.

Locality.	Water.	Gas.	Sulphur.	Fixed Carbon.	Ash.	Calorific Value.	Specific Gravity.	Date of Assay.
1. First sample obtained from River Bed, near T. 26	15·20	32·46	2·23	45·03	5·08	...	...	19-11-89
2. A few feet deep in the same seam ...	12·75	37·04	0·71	46·70	2·80	...	...	0-3-90
3. From 17ft. deep in the same seam ...	10·87	31·47	2·23	52·87	2·56	...	...	21-4-90
4. Same seam, sample from top	13·65	34·88	1·09	48·35	3·12	6·06	...	9-10-91
5. Do. bottom ...	13·85	35·90	1·18	45·93	4·32	6·06	...	9-10-91
6. Shaft sunk by Mr. Pendleton on the same seam, a few chains further east	7·94	29·70	0·00	55·75	6·61	7·7	...	23-2-93
7. Shaft sunk by Mr. Pendleton on the same seam, a few chains further east	13·30	22·08	0·53	56·36	8·26	7·7	...	10-4-93
8. From the same seam 100ft. from surface	11·40	35·94	0·00	50·85	1·81	...	1·291	21-5-95
9. From outcrop at T. 17	11·70	21·83	2·99	54·17	9·31	...	...	2-4-90
10. Do. a little deeper ...	7·00	37·57	...	51·89	3·54	...	1·308	21-5-95
11. Diamond drill No. 2 bore, 61ft. from surface, 2ft. 7in. seam	11·00	33·98	...	52·83	2·19	7·26	...	17-1-95
12. Diamond drill No. 2 bore, another seam 133ft. from surface, 8ft. 3in. seam	11·27	32·76	...	53·51	2·46	6·93	...	17-1-95
Average of twelve samples ...	11·60	32·10	0·90	51·20	4·35	...	...	...

Note.—All these Assays, with the exception of No. 2, which was made at the Royal School of Mines, London, were made by the Government Assayer.

Comparison of the Collie Coal with Coals from New South Wales and Victoria.

Average of	Valueless matter.		Fuel.	
94 samples of New South Wales coal	Water ...	2·22	Gas...	29·53
	Ash ...	8·57	Fixed Carbon	61·98
	Totals	10·79	... ...	91·51
17 samples of Victorian coal	Water ...	5·78	Gas...	29·725
	Ash ...	8·57	Fixed Carbon	55·522
	Totals	14·35	... ...	85·247
12 samples of Collie coal	Water ...	11·50	Gas...	32·10
	Ash ...	4·35	Fixed Carbon	51·20
	Totals	15·85	... ...	83·30
Latest sample from the Collie	Water ...	7·0	Gas...	37·57
	Ash ...	3·54	Fixed Carbon	51·89
	Totals	10·54	... ...	89·46

From this it will be seen that the average of 12 samples, mostly taken from the outcrop, are very nearly as good as those from the Victorian mines, whilst the best sample from the Collie is better than any Victorian coal, and very nearly as good as the average of the 94 samples of New South Wales coal now in the market.

After allowing for loss of fuel in converting contained moisture into steam, they bear the following comparison to one another:—

	New South Wales.	Victoria.	Average of 12 samples of Collie.	Best sample of the Collie Coal.
Loss per 100 tons... ...	11% ...	15% ...	17·5% ...	11·5%

The best sample of Collie coal is therefore half a ton inferior to the average New South Wales coals, and three and a half tons better than the Victorian coals.

Besides the development at the mine, a series of diamond drill bore holes have been put down to test the extent of these coal seams.

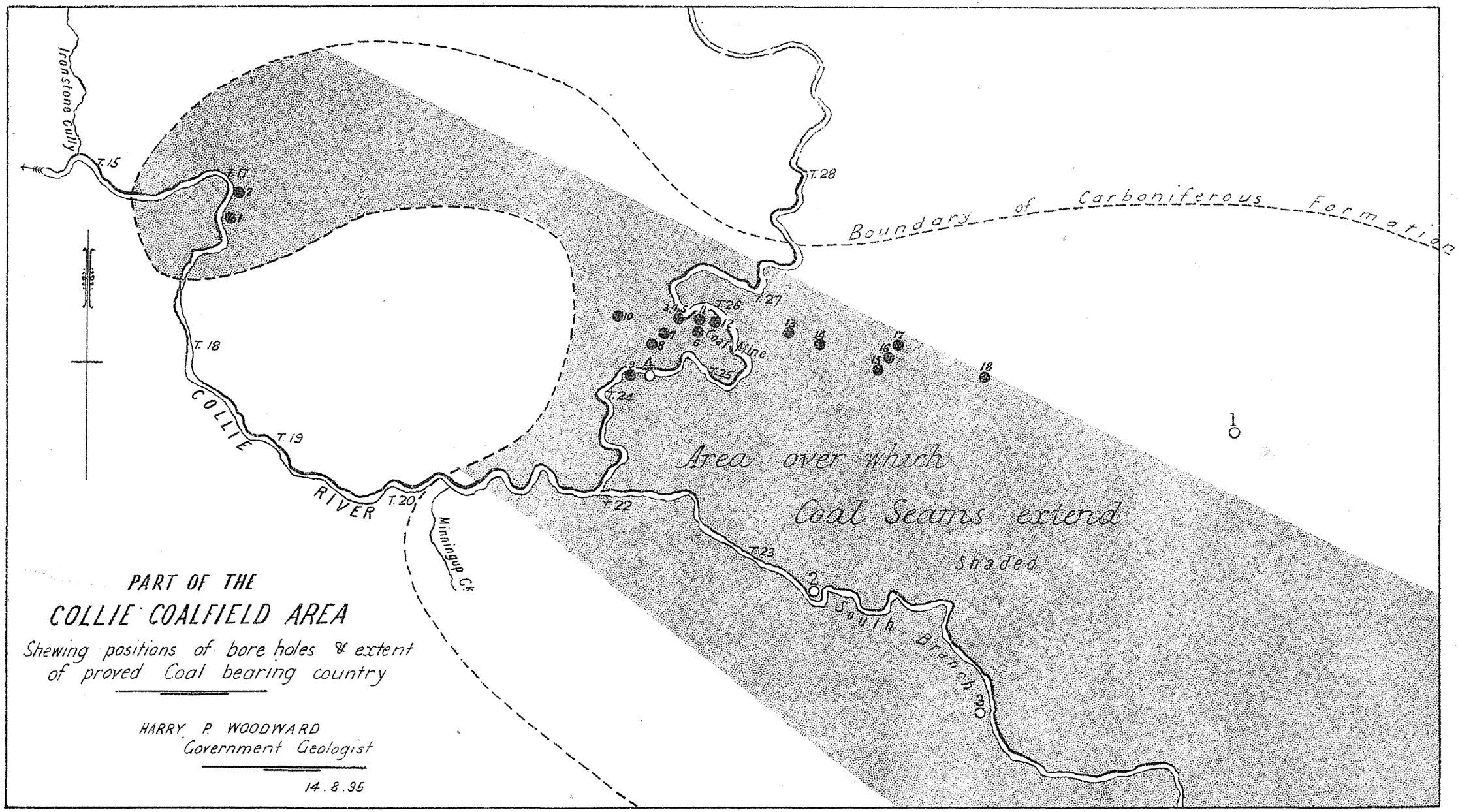
No. 1 diamond drill bore hole was put down at a point on the Northern edge of the basin, about five miles in an East-South-Easterly direction from the mine, and about 3 miles in the same direction from No. 18, the last bore hole being put down with the jumping drill. In this bore hole granite was encountered at a depth of 420 feet, whilst only a few inches of coal were passed through near the surface, which clearly proves that the site selected was a little too far to the Northward of the outcrop of the coal measures, since only the lower shale beds of the series were met with.

No. 2 bore hole is situated about $2\frac{3}{4}$ miles South-East of the mine, upon the South branch of the Collie River. This site was selected as being well within the area, and probably near the centre of the basin, and this proved to be the case, since the coal measures series was passed through for a depth of 961 feet, at which depth boring was discontinued. In this bore hole thirteen seams of coal were passed through, the largest at 133 feet from the surface, being 8 feet 3 inches.

No. 3 bore hole is also situated upon the South branch, about two miles further up it, and about $4\frac{1}{2}$ miles in a South-Easterly direction from the mine. This bore hole was put down 272 feet, and in it 14 feet 3 inches of coal was passed through, the largest seam being 5 feet in thickness.

No. 4 is situated upon the main Collie River, about $\frac{1}{2}$ mile South-West of the mine, and about 11 chains West of No. 9 jumper drill bore hole. This bore is not yet completed, but at a depth of 350 feet a small seam of coal was met with.

The following table gives full particulars of the seams of coal met with in all the bores put down upon the field, with their thickness and depth from the surface, whilst the map shows their position and proved area.


Ironstone Gully
T. 15
T. 17
T. 18
T. 19
T. 20
T. 22
T. 23
T. 24
T. 25
T. 26
T. 27
T. 28
COLLIE RIVER
Minningup Ck
Coal Mine
Boundary of Carboniferous Formation
Area over which Coal Seams extend
Shaded
South Branch Coy
PART OF THE
COLLIE COALFIELD AREA
Shewing positions of bore holes & extent of proved Coal bearing country
HARRY P. WOODWARD
Government Geologist
14.8.95

EIGHTEEN BORE HOLES PUT DOWN WITH A HAND DRILL.

Number of bore hole	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Distance from mine	5 miles	5 miles	5 chains	5 chains	5 chains	10 chains	20 chains	30 chains	40 chains	40 chains	The mine.
Direction from mine	W.	W.	N.W.	N.W.	N.W.	S.	S.W.	S.W.	S.W.	W.	...
Total depth bored	50ft.	20ft.	...	200ft.	19ft.	136ft.	184ft.	150ft.	194ft.	245ft.	30ft.
Number of seams	1	1	0	9	1	5	0	1	2	2	1
Aggregate thickness of coal	2in.	3ft. 10in.	...	34ft. 4in.	11ft. 3in.	18ft. 6in.	...	11in.	9ft. 3in.	3ft.	12ft.
	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.		Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.		Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.
	0 2 at 37 0	3 10 at 2 9		17 11 at 40 0	11 3 at 10 0	1 0 at 42 0		0 11 at 123 0	0 11 at 58 0	1 0 at 77 0	12 0 at 17 0
				1 7 ,, 64 0		7 0 ,, 62 0			8 4 ,, 110 0	2 0 ,, 80 0	
				0 3 ,, 120 0		2 0 ,, 91 0					
				4 0 ,, 124 0		1 0 ,, 102 0					
				2 9 ,, 130 0		7 6 ,, 127 0					
				4 0 ,, 152 0							
				2 0 ,, 167 0							
				3 6 ,, 172 0							
				0 2 ,, 178 0							

EIGHTEEN BORE HOLES PUT DOWN WITH A HAND DRILL—*continued.*

Number of bore hole	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
Distance from mine	10 chains	58 chains	78 chains	115 chains	115 chains	115 chains	169 chains
Direction from mine	E.S.E.	E.S.E.	E.S.E.	E.S.E.	E.S.E.	E.S.E.	E.S.E.
Total depth bored	41ft.	63ft.	40ft.	84ft.	250ft.	101ft.	100ft.
Number of seams	1	2	0	3	9	2	3
Aggregate thickness of coal	22ft. 2in.	16ft. 4in.	...	2ft. 5in.	38ft. 5½in.	4in.	5ft. 11in.
	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.		Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.
	22 2 at 18 0	6 10 at 15 0		0 7 at 44 0	1 2½ at 53 0	0 3 at 35 0	1 1 at 47 0
		9 6 ,, 26 0		0 6 ,, 58 0	10 1 ,, 92 0	0 1 ,, 45 0	3 4 ,, 65 0
				1 4 ,, 80 0	0 7½ ,, 115 0		1 6 ,, 85 0
					4 3 ,, 167 0		
					4 8 ,, 173 0		
					2 10 ,, 193 0		
					1 1 ,, 224 0		
					3 11 ,, 225 0		
					9 9½ ,, 230 0		

FOUR DIAMOND DRILL BORES.

Number of bore hole	No. 1	No. 2	No. 3	No. 4
Distance from mine	5 miles	2¾ miles	4½ miles	½-mile
Direction from mine	E.S.E.	S.E.	S.E.	S.W.
Total depth bored	420ft.	961ft.	272ft.	350ft.
Number of seams	1	13	8	1
Aggregate thickness of coal	3in.	18ft. 5in.	14ft. 3in.	6in.
	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.	Thickness of seam. ft. in. / Depth from surface. ft. in.
	0 3 at 117 0	2 7 at 63 0	2 8½ at 37 0	0 6 at 350 0
		8 3 ,, 133 0	1 6 ,, 39 0	
		0 2 ,, 246 0	0 3 ,, 108 0	
		0 10 ,, 254 0	1 5 ,, 150 0	
		0 8 ,, 302 0	5 0 ,, 161 0	
		0 4 ,, 313 0	2 3½ ,, 180 0	
		0 4½ ,, 319 0	0 7 ,, 227 0	
		0 6½ ,, 324 0	0 6 ,, 239 0	
		0 8 ,, 367 0		
		0 9 ,, 430 0		
		1 0 ,, 721 0		
		1 0 ,, 767 0		
		1 3 ,, 960 0		

These bores clearly prove that a belt of country of about 14 square miles, containing workable seams of coal, extends in a South-Easterly direction from the main Collie River for a distance of about four miles, or roughly speaking, it follows up the valley of the South branch lying immediately to the Eastward of the range.

This proved area must not in any way be confused with the entire area over which workable coal seams may extend, which will prove to be considerably larger.

Large seams of coal have been proved, by the means of drills, to exist, extending over a considerable area; the quality has both been proved by assays and practical tests in quantity from the mine; therefore, the Collie Coalfield is an established fact—the next stage in its development must be capital and labour.

HARRY P. WOODWARD,
Government Geologist.

16-8-95.

Appendix 3.

Report by the Government Assayer to the Under Secretary for Mines.

I have the honour to report, for the information of the Honourable the Minister for Mines, that during the year ending 31st December, 1894, I made two hundred and forty-eight (248) assays, viz.:—

Gold.	Silver.	Tin.	Tungsten.	Bismuth.	Lead.
230	8	7	1	1	1

and that during the twelve months from 1st July, 1894, to 30th June, 1895, the number was four hundred and sixty-four (464) as under:—

Gold.	Silver.	Tin.	Wolfram.	Bismuth.	Copper.	Mercury.
444	13	3	1	1	1	1

These figures show that the search for minerals is increasing very rapidly, although, at present, little is sought except gold.

A few specimens of mica and asbestos have been brought to me during the year.

BERNARD H. WOODWARD,
Government Assayer.

6th August, 1895.

Appendix 4.

REPORT

ON THE

INTERIOR GOLD REGION

OF

WESTERN AUSTRALIA,

BY

S. GÖCZEL,

Mining Engineer and Metallurgist,

ASSISTANT GOVERNMENT GEOLOGIST.

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THE INTERIOR GOLD REGION OF WESTERN AUSTRALIA,

By S. GÖCZEL.

I.—EXTENT AND GENERAL GEOLOGICAL DESCRIPTION.

From a general point of view, the geological formations and features of the interior goldfields offer very little variety.

Several of them, which show at first sight striking contrasts, are found under further observation to stand in close connection the one with the other.

Identical agencies, acting on lythological objects of similar if not identical constituents, have produced features which may be considered as links of chains, in which the end links, if compared, will show remarkable distinctions, whereas the difference between adjoining links is hardly perceptible.

For cases such as these, the intensity of the action, together with its length of time and also other surrounding conditions, almost always offer a satisfactory explanation.

Other minor modifications in neogene geological features are due to climatic conditions and altitude.

Whilst passing through the interior Goldfields, and keeping those facts in view, we become aware that their boundaries do not enclose naturally distinct areas, and that the proclaimed Goldfields are only arbitrary subdivisions of one gigantic geological region,—"*the interior gold region of Western Australia.*"

It is not possible to define the N.E. extent of that region at the present time, as very little geological information about that part of the Colony has been obtained.

The presence and great development of sedimentary paleozoic rocks in the North-West of the Colony,* and the insignificant occurrence of such rocks in the interior gold region, form conditions for a natural and traceable boundary in that direction.

That portion of the great West Australian tableland which is situated to the West and South of the interior gold region—although to some extent of physical and geological similarity—shows sufficient distinction for the demarcation of the latter in those directions.

In the Western and Southern portions of the plateau comparatively few and small disturbances have occurred, excepting the general corrugation of the prevalent archæan strata, and paleozoic eruptive rocks have a limited development; whereas the interior gold region distinguishes itself by its broken character, a great number of enormous dislocations and subsidences of the strata, prevalence of paleozoic eruptive rocks (massive and schistose), and the occurrence of rich gold deposits in connection with those features.

Towards the South-West the plateau itself, and with it the interior gold region, terminates by a depression, in which the principal rocks, according to Mr. Victor Streich, geologist to the Elder Exploring Expedition, are of mesozoic age. †

The interior gold region, bordered by the above-described natural boundaries, and supposing it to have a probable North-East extent, would occupy, approximately, an area of 120,000 to 140,000 square miles.

Observations made during my travels through the goldfields lead me to conclude that about four per cent. of the above area actually contains auriferous deposits; therefore about 4,800 to 5,600 square miles, distributed here and there in easily distinguishable belts and patches within the whole region, will probably be found to contain auriferous deposits.

The archæan rocks form the basis of the whole great interior tableland. Rising into elevations within the auriferous region, they are sometimes overlaid by cappings and beds of ferruginous grits sandstones, and conglomerates, which hardly ever attain any considerable thickness.

Those strata are more prevalent in the Northern parts, and, although bare of paleontological proof, are probably representatives of the Cambrian section.

We meet with strata of the same section in the Southern parts, chiefly in the Lake Cowan country, and in the Dundas Hills on a relatively similar level, but at considerably lesser absolute height. In those parts of the country those strata are usually protected by overlaying greenstone formations, and show their development in form of quartzite banks, conglomerates, shales, and phyllites.

The old greenstones (diorite, diabase, gabbro), including the schistose and banded features (feldspar-amphibolites, schists, etc.), form hills and ranges along gigantic breaks in the archæan strata; they generally also indicate those stretches of country in which gold deposits occur.

* H. P. Woodward, Government Geologist, Western Australia, Annual General Report, 1890. † Transactions Royal Society, South Australia, Vol. XVI.

There can be hardly any doubt that the old greenstones are eruptive rocks of the paleozoic era; the features and forms under which they here appear, also their mineralogical composition and geological situation, lead to the convincing belief that most of the formations in which they take prominent part are volcanic features, and ruins of long extinct volcanoes.

The numerous ranges and hills of insignificant height and rugged appearance, which are so often met with in the auriferous region, have once formed part of volcanic cones, and the far extending greenstone banks and cappings are remnants of old lava streams.

Tangential pressure, acting continuously through geological ages, and the weight of the once overlaying, but now denuded strata, have produced schistose and occasionally traverse cleavage structure.

During the paleozoic ages, volcanic magma and material was emanated through vents along the numerous breaks in the archæan earth crust, and mountains were formed in a similar way to the growth of recent volcanoes, subsequent subsidences, fumarola and solfatara action, thermal springs, the cessation of volcanic activity, rock alteration by dynamic, thermo-chemical, and chemical processes (the first affecting principally the texture, the others chiefly the mineralogical and chemical composition of the rocks), breaks, fissures, and consequent formation of dykes and lodes, mechanical disintegration, decomposition, denudation, accumulative decomposition, erosion, the formation of sediments (chiefly lacustrine sediments), and also æolian energy, have transformed the once volcanic region, and imparted to it, during an incalculable interval of time, its present character.

The gold deposits occur in stretches of country the longitudinal axes of which strike in various directions; but in travelling over the country, the prevalence of a general N.W. tend can hardly remain unobserved.

It is not a matter of accident, but of cause and effect, that most of the stretches of country containing gold deposits are situated in the vicinity of saline depressions and so called salt lakes; they usually extend along lines of breaks and subsidences.

The ejection of huge masses of volcanic material to the surface has necessarily left large cavities underneath—the subsequent breakage and subsidence of the earth-crust, which has formed the roofs of such cavities, have caused the depressions which appear now as saline flats and salt lakes.

In such localities we are able to discern one portion of country which has remained in a relatively original position, and another which has subsided.

In the former archæan rocks occasionally rise to the surface, and it is principally in the contact zones between those rocks and the greenstones that the richest and most numerous gold deposits are to be found.

It is only natural that along a line of subsidence a great number of fissures broke open. In some of those volcanic magma rose towards the surface and became solidified within; they form dykes. Segregation, pure and simple, has formed many quartz reefs.

During subsequent movements in the earth crust, already complete quartz lodes were broken through and sometimes dislocated by newly-formed fissures, and in some instances the original lode fissure was partly re-opened.

Fractured portions of such broken reefs gave easy access to circulating mineral solutions; and if those solutions were derived from subterranean solfatara action, and were auriferous, these conditions favoured the formation of rich gold-shoots and auriferous ore-columns in otherwise poor, or barren, quartz reefs.

There are unmistakable traces of subterranean solfatara action and hydrothermal activity encountered in many of the primary gold deposits which are already opened by mining enterprise.

In some of the lodes the greatest part of the fissure is filled with material derived from the adjacent country rock. Subterranean solfatara action has extracted, and the thermal waters have transported such material through fissures towards the surface, and, under favourable conditions, part of the chemically dissolved, as well as mechanically deposited, mineral matter was deposited.

Along zones of contact between gneissic granite and greenstones, lodes or reefs are usually found to occur in both formations, and occasionally passing from one into the other.

Auriferous stone, derived from lodes extending in gneissic granite, differs to some extent from that obtained from lodes which have greenstones as country rock. The latter is generally more ferruginous in the upper, and contains more sulphites and arsenites in the lower levels.

Differences in the gold distribution, in the occurrence of ore shoots, and in the dimensions of the latter, can also be observed in the lodes passing through those two distinct country formations.

Equal conditions for the filling of the lode fissures admitted, the mineralogical composition and physical character of the country rocks offer sufficient explanation for those differences.

In various localities of the interior gold region, and usually in the vicinity of auriferous lodes and reefs, beds formed by thermal waters, or under their co-operation, have been found to contain gold.

The material of such beds, even in one deposit, is often found to vary. It is more or less of felsitic and dolomitic nature, with a considerable mixture of ferruginous clay. Silicious sinter, silicious ferrosiderite, and travertine are occasionally met with.

"Opaline and Cement" are locally applied names for the material of such deposits.

The breaks and faults in quartz reefs have sometimes served as vents for thermal waters. In a few instances outcropping gold shoots are recognisable as such vents, and their connection with adjacent auriferous cement deposits is almost evident.

Small rounded quartz fragments, and small quartz crystals, with rounded edges, are found embedded in the cement between large, sharp-cornered fragments of lode-quartz and country rock. They are very similar to the small rounded stones in bubbling springs, and occur only in the vicinity of such supposed vents.

The bulk of the cement beds is a precipitate from overflowing thermal waters, and the gold contained in them is the same.

In most cases the absence of water-worn gravel excludes a pure and simple fluviatile alluvial origin of those gold deposits, which therefore must be ranked as primary.

II.—GEOLOGICAL HISTORY.

The geological monuments in the gold region are bare of paleontological remains; but none the less, taken in conjunction with features of adjoining areas, they open a retrospective view into the early geological history of that portion of the Colony.

The growth of the Western portion of the Australian continent began with this tableland formation.

Archæan portions of the lythosphere, forced by tangential pressure towards the surface of a paleozoic ocean, have formed sub-oceanic elevations extending longitudinally in a west of northerly direction.

Breaks in the archæan earth-crust took place on the eastern declines of those elevations, and volcanic action of intense degree began to manifest itself.

In consequence of tangential pressure, and disposal of volcanic magma and material, sea bottom rose above the ocean, and islands appeared.

Towards the end of the paleozoic era, in all probability the auriferous region would have presented itself as a volcanic archipelago, situated to the east of one large island, with a west of northerly longitudinal extent.

The latter now forms the portion of the great West Australian plateau, adjacent to the interior gold regions towards the west; it is the archæan nucleus around which the Western part of Australia was gradually built. To that nucleus was joined the gold region, by secular upheaval.

During the later periods of the paleozoic era intense volcanism and active emanation of volcanic magma proceeded with the recession of the ocean, in a South-Easterly and Easterly direction.

The massive diorites and schistose feldspar-amphibolites are older than the diabases and their schistose features.

The latter are more prevalent in the South-Eastern and Eastern portions of the gold region. In numerous cases they break in form of dykes through the dioritic rocks.

At the beginning of the mesozoic era a more general upheaval was completed, and volcanism, in this portion of the globe, apparently had lost its intensity, and manifested itself chiefly in seismal and hydrothermal activity.

Doubtlessly the formation of lodes commenced with the first break in the lythosphere, but the formation of the bulk of primary gold deposits in this region is due to a hydrothermal gold emanation, most probably connected and caused by volcanic subsidences during the late periods of the paleozoic era.

The elevation of the country above the sea, and the later cessation of volcanism and volcanic after-action, have inaugurated a new era, during which great depressions, occupied by inland lakes and estuaries, were successively filled in with rock material, derived from the adjacent high country.

In the earlier periods of that era, hydraulic actions chiefly performed that work, which later on became gradually entrusted more and more to chemical and æolian agencies.

III.—PHYSIOGRAPHY, INCLUDING SUBTERRANEAN JOURNEY AND ACTION OF THE METEORIC WATERS.

The interior gold region covers part of the Eastern portion of the great West Australian table-land. In the adjoining Western portion the archæan strata are corrugated, but only slightly jointed and fractured, the geological uniformity being hardly interrupted.

In the gold region the same strata appear as more or less separated, elevated portions, surrounded by schistose greenstone ranges and saline depressions.

Those ranges and depressions impart to the gold region a certain distinctness.

The archæan elevations, to which *nota bene* the preservation of the tableland appearance is due, might be regarded as massives, and also as component orographic units in the formation of this portion of the great tableland. Their surfaces usually present slightly undulating plains, covered with sand and gravel; massive dome-shaped granite rocks also occasionally crop out.

The course of the gigantic divisional breaks between the separated archæan portions—although not regular—shows a North-Westerly average tend, whereas an average line derived from the axes of the general corrugation folds tends slightly West of North.

Erosion has imparted a precipitous character to ravines, which separate different steps of plains. Most of those ravines are old lacustrine strands, and in the Northern portions of the gold region their height often reaches fifty feet and sometimes more. Their gradual decrease into hardly perceptible rises of the country is not unfrequent.

The table-tops, as locally named, are remnants of denuded portions of high plains; they are flat-topped elevations, bordered all round by more or less precipitous descents.

Proceeding from the North in a Southerly direction, the borders of archæan elevations assume successively more and more the forms of gentle slopes, which occasionally are interrupted by massive granite outcrops, these being the more resistive portions of the archæan strata.

We have here a gradual transit, due to the gradual recession of the paleozoic ocean towards the South and South-East.

The waves of that retiring, shallow ocean had a longer time in which to obliterate the unevennesses along lines of dislocation situated in the South and South-Easterly portion of the gold region, than they had in the Northern.

Comparatively low and rugged ranges and hills, consisting chiefly of altered schists and of schistose and massive greenstones, follow the more or less irregular courses of breaks in the archæan lythosphere. They are remnants of denuded, once gigantic, volcanic features.

Wide flats occupy a large portion of the interior gold region. Their surface formations are usually neogene, of lacustral, fluviatile, subaerial and also æolian origin. Probably they overlay conformably lacustral and fluviatile formations of the mesozoic era.

The interior gold region has only a very slight, if any, drainage towards the sea.

The meteoric water supply is fully balanced by evaporation, and also by absorption, in the continuous process of mineral alteration.

The surface strata are very porous, and there are no running rivers and rivulets.

Creeks and gullies, eroded in declines of ranges and elevations, are short, and all traces of them are soon lost in sandy flats. Their beds are mostly dry, but in some cases water may be found for some considerable time after a rainfall in intervening deepenings. Such water reservoirs occur more frequently in the Northern parts.

Massive granite outcrops contain basins and rock-holes, which have gradually weathered out in places where the granite had less resistibility against decomposition. Such rock-holes are locally called "Namma holes."

"Native wells and soaks" are usually situated at the base of outcropping granite rocks, and roughly deepened into rock fissures. Water collected in such fissures, and in higher situated saturated detritus—standing in communication with them—will drain into these wells and soaks, until the subterranean supply, down to the level of the well-bottom, becomes exhausted.

Fresh water pools, into which the rainwater of an adjacent area is collected, and which, in consequence of the imperviousness of the clayish beds, is retained for some time, are locally termed "claypans."

Saline flats and salt lakes extend usually along breaks in the archæan lythosphere. They form the area of drainage and evaporation for the bulk of meteoric waters which descend within their watersheds.

In dry seasons evaporation dries up the greatest part, if not the whole, of some of the lake basins.

The strata forming the bottom of salt lakes are usually permeable for water, and the water level recedes in some cases, and especially in dry seasons, to a considerable depth underground.

The drainage towards the lakes is effected in subterranean conduits, and also by percolation.

The subterranean influx into dry lake basins can be observed after a heavy rainfall. The surface-layer of such dry lake basins consists of a hard, salty, argillaceous sand crust, which usually covers a pulverulent and permeable stratum of lacustrine sediment.

The underground water influx causes a pressure on the upper crust from below, and forces the lake-bottom into calotte elevations, sometimes above an already accumulated shallow sheet of water. The tops of those elevations burst, and water flows out of the crevices.

It will be advisable to consider separately the journey and action of the meteoric waters in the archæan elevations. The latter, with the exception of the outcropping dome-shaped or flat granite rocks, are mostly covered by æolian or subaerial formations.

Quartz and gravel accumulations, the remnants of hydraulic and æolian denudation, and minor lacustrale and fluviatile features embedded in erosive depressions, may be mentioned as overlaying strata of more limited occurrence.

An upper zone of the archæan rocks is usually decomposed. The decomposition reaches various depths, and consists generally in the complete kaolinisation of the feldspars, and, in the more or less advanced change of the biotite, into a pale, talc-like, hydrous mineral; the quartz individuals being hardly affected.

The decomposition is due to the following process:—

The rain-water dissolves carbonic acid in the atmosphere, and, provided with that powerful agent, enters the pores and fissures of the gneissic-granite. By degrees it produces in the feldspars a conversion of the alkali silicates into carbonates, and receives the latter, together with liberated silica in solution. With the hydration of the remaining hardly soluble silicate of alumina, the kaolinisation is effected.

In a similar way the removal of bases in the mica (chiefly biotite) takes place, and, where decomposition in the rocks is most advanced, this mineral is replaced by pale talc scales.

The silica liberated in that process (about two-thirds of the quantity contained in the decomposed silicates; and soluble in 10,000 parts of water) has entered solution, but has not been far removed.

It supplied material for the formation of quartz deposits, and also for the silicification of already decomposed portions of gneissic-granite, and their alteration into rock enclosures of porphyritic habitus and granophyre-like appearance.

By that process of decomposition, enormous quantities of mineral-matter have been removed in solution, and the original gneissic-granite became converted into a white, gray, or yellow friable rock, to a greater or smaller depth according to the degree of resistiveness.

In some of the wells and shafts this zone of decomposition *in situ* has been found to reach a depth of over 100 feet below surface.

Joints and fissures, especially in granitic rocks, promote a local downward progress of decomposition.

Various degrees of resistibility against decomposition, as well as the number and size of joints and fissures, chiefly influence the formation of the subterranean surface features of the still solid rock.

In case of a removal of the decomposed rock, those features would present themselves as elevations and depressions (ridges, basins, and channels).

In consequence of chemical removal of great quantities of mineral matter, the decomposed archæan rocks have acquired a comparatively large storage capacity.

The rain-water entering the porous rock travels centripetally till the underlaying solid unpermeable rock, or a plane of complete saturation in the former, is reached. In the first case the configuration of the solid rock will prescribe the conditions for the progress of the water until a plane of complete saturation is reached.

From thence the outfall towards the drainage area decides the further movements of the meteoric waters.

On their journey through pores and fissures of archæan rocks the percolating waters become chiefly charged with alkaline, calcic, and magnesic carbonates.

Well water in the archæan rocks, if tapped above the water level of the drainage area, should be found potable.

Occasionally, even under the above condition, the water is heavily mineralised, and perhaps saline. In such cases the mineralised character and salinity are usually due to some overlaying older lacustrine formation or to saline sand drifts.

In the greenstones, especially in the most abundant feldspar-amphibolites and diorites, the circulating waters perform also important rock alterations, and soon become charged with dissolved mineral substance.

Those rocks are often altered to a great depth, and their original constituting minerals are converted into new ones by removal of bases and hydration.

A reddish brown ferruginous clay is the usual result of the commonly occurring surface decomposition of greenstones. Below the surface the decomposition of the feldspar-amphibolites shows variety.

The constituting minerals of this rock are plagioclase or triclinic feldspar and hornblende. The first becomes kaolinised, and during the process of kaolinisation carbonates of lime and of sodium enter into solution.

Various hydrous silicates of alumina, magnesia, and protoxide of iron are various results of decomposition of the hornblende.

Removal of lime, magnesia, hydration, and conversion of the protoxide into a hydroxide of iron produce as residue a ferruginous clay. Chlorite is formed by removal of the lime and hydration; epidote by removal of the magnesia and secretion of silicia and carbonate of lime; serpentine by complete removal of alumina, lime, partly removal of iron, and by hydration.

In very large portions of the decomposed greenstones hornblende and augite are altered into chlorite and delessite—therefore the original rocks into chloritic schists.

It may be just mentioned that the large quantities of brown hematite found in the auriferous region, and also the ferruginous crusts covering and penetrating diorite and amphibolite fragments and outcrops, are chiefly derived from the decomposition of hornblende and augite.

The iron contained in those minerals as protoxide-silicate becomes converted during the process of decomposition into ferrus carbonate, which by further oxidation is transformed into iron-hydroxide.

Pyrites occur as accessory minerals, abundantly disseminated through the greenstones. Sulphuric acid results from their decomposition, giving occasion for the formation and solution of sulphates, and also for decomposition and solution of aluminous silicates.

Enormous quantities of chlorides (chiefly common salt) were and are still liberated from viscicular enclosures during the continuously progressing rock alteration and disintegration. They readily have joined the percolating waters.

Schistose and cleavage structure, fissures, and dislocation faults facilitate the reception and percolation of meteoric waters in the amphibolites. Capillary resistance does not much retard them on their downward way, and the plane of complete saturation or water-level is soon reached.

The massive greenstones with granite texture are more resistive against penetration, and, therefore, decompose at a far slower rate; within their occurrence higher situated areas of complete saturation may occur, which, if tapped, will supply tolerably potable water.

Generally on their subterranean journey through the greenstones the waters become charged with carbonates of sodium, lime, magnesia, and also with considerable quantities of sulphates and chlorides, which soon render them unpotable and unfit for domestic purposes.

The meteoric waters, after having passed through the silicate rocks and performed their work of mineral decomposition, arrive as concentrated mineral solutions in their area of drainage, and partly replace the diminution of water caused by evaporation.

When those mineral solutions enter the highly concentrated salt waters of their area of drainage, most of their lime, and also magnesia, become precipitated as carbonates.

Calcareous and dolomitic tuffs, consisting of such precipitates, intermixed with gypsum, common salt, and detrital matter transported by wind into the lakes, form usually the beds of the inland salt lakes within the auriferous region.

The salinity of the waters collected in lacustral depressions has increased already to a very high degree, and the dissolved salts are chiefly chlorides of sodium and magnesium, with sulphates of calcium and magnesium.

Sedimentary formations of considerable depth, and consisting chiefly of calcareous and dolomitic material, occupy wide spaces, which doubtlessly were once lacustrine ingressions. Occasionally they reach the surface, but they are generally covered by neogene, subaerial, and to a small extent also fluviatile features.

At a depth usually stratified, the outcrops of those sedimentary formations, consist chiefly of a pulverulent dolomite sand, a residue after removal of the carbonate of lime. Where a removal of the carbonate of magnesia has also taken place, a ferruginous clayish residue is left.

Out of higher situated subterranean portions of those older lacustrine beds, chlorides and sulphates are already leached by percolating waters; and wells, reaching completely saturated strata at such higher level, supply potable water.

IV.—THE FLORA TAKEN IN RELATION TO THE SURFACE FORMATIONS.

The flora of the auriferous region of the interior presents itself in distinct floral belts and areas, which are chiefly produced by the constancy of the vegetation on certain geological surface formations.

Differences in the level influencing the moisture of the soil cause by that means also abrupt changes in the vegetation.

Certain hygrophile Acaciæ, Casuarinæ and Santalacoæ serve already as valuable guidance in the search for subterranean water and in certain cases, by observation of the floral distribution, even from a distance, reliable geological deductions can be arrived at.

The following table shows the most prominent soils of the auriferous region systematically arranged.

Soil formed *in situ*.		Soil consisting of shifted material.		
By accumulative decomposition	By surface accumulation of more resistive and bulkier rock fragments, during hydraulic or æolian denudation.	Alluvial Soil.	Soil consisting of æolian origin.	Soil precipitated from solutions.
a. Argillaceous sand derived from archæan rocks.	*a.* Light coloured stony soil derived from archæan rocks and also from cambrian conglomerates and sandstones.	*a.* Fluviatile alluvium.	*a.* Loess.	*a.* Banks of pulverulent gypsum.
b. Ferruginous clay derived from paleozoic greenstones.	*b.* Ferruginous brown coloured stony soil derived from paleozoic greenstones.	*b.* Lacustrine alluvium (saline).	*b.* Recent æolian sand drifts.	*b.* Recent lacustrine tuffs.
c. Tuffs (dolomitic, calcareous, and silicious), derived from older lacustrine sediments.				

There is not much difference in the composition of the various corresponding soils in the North and in the South, but climate and alterations in the extensional proportions of the different geological surface formations produce, necessarily, differences in the general appearance of the respective flora.

A certain gradual minor geological alteration is caused by a general rise of the country Northwards, and in the increasing abruptness of the meteoric precipitations as we approach the Tropics.

Owing to this hydraulic denudation, transport, and deposition of rock material increase their field of action Northwards; erosive depressions and fluviatile alluvium increase at the expense of older lacustrine formations and of loess; areas of hydraulic as well as æolian denudation grow also gradually larger and larger, whereas the accumulative decomposition decreases in a similar ratio.

The denudation is usually only partial, the more resistive and bulkier rock fragments are not removed, and the less resistive portions, after crumbling to dust, are washed down to lower levels, or carried away by winds.

In the North this natural separation of rock detritus into disgeogene* and eugeogene† soil has taken place to a greater extent than in the South, and discloses itself in very pronounced floral contrasts.

The high water lines of the various areas of drainage form general boundaries for the saline soil, and therefore also for the saline flora. Saltbush (halophytes) is often found on higher levels. In such cases the salinity of the soil is due to æolian transport and disposal of salt derived from dried-up lake beds, or to salt contained in older lacustrine beds.

The larger forms of flora are chiefly represented by the genera *Eucalypti* and *Acaciæ*.

Both genera possess xerophile and hygrophile species, which accordingly represent their genus on soils of various hygrostatic degrees.

The predominance of genus *Eucalypti* in the Southern, and of genus *Acaciæ* in the Northern portion of the auriferous region, is due to climatic conditions.

A gradual transit is distinguishable between a Southern *Eucalyptus* belt into a Northern *Acacia* belt. A zone of transit extends more or less between latitudes 30° and 29°. To the South of this extensive *Eucalyptus* forests are found, and to the North dense mulga scrub *(Acaciæ)* are the general floral feature.

Both those floral zones, the *Eucalyptus* forest zone in the South, and the mulga scrub zone in the North, extend beyond the respective limits of the auriferous region.

The reddish-brown coloured loess soil occupies by far the larger portion of the interior gold region.

In the South zone the larger species of *Eucalypti* find their most favourable development on that soil, and also on older lacustrine formations which have already undergone a process of leaching and decomposition.

The latter formations present themselves usually as patches of calcareous or dolomitic tuffaceous soil, and principally bear gimlet-wood.

White and red gum trees show a preference to growing in the lower situated portions of the loess flats; the so-called salmon-coloured gum tree thrives on higher situated ground also, and the mallee gum, showing in the least hydrophile tendencies, occupies even highly-situated disgeogene soil.

Acaciæ are of more rare occurrence in the South zone, and occupy chiefly soil formed *in situ* by accumulative decomposition. Wattle and jam trees are the most hygrophile species, and their occurrence indicates usually a moist decomposed rock stratum with the solid rock at a small depth beneath the surface.

* Stony soil, resistive against weathering. † Earthy (clayish, sandy) soil.

Larger species of *Casuarinaceæ* favour similar ground.

The species of *Acaciæ* forming the so-called mayol scrub are to a lesser degree hygrophile, and have therefore a wider extent.

Elevated areas in the South as well as in the North have usually a disgeogene surface soil and therefore a stunted xerophile flora which is much less influenced by climatic differences than the flora of the deeper situated loess country.

The surface soil of such areas is usually drift sand and gravel resulting from rock decomposition and partial æolian or hydraulic denudation.

Proteaceæ, *Epacridaceæ* and *Spinifex* are here predominant, and species of the dreaded West Australian poison plants *(Gastrolobium* and *Oxylobium)* are often met with. Desert gum trees and stunted mallee bushes occur occasionally in smaller patches.

Large prickly spinifex tufts always cover pronounced æolian drifts and formations, and secure to a certain degree their stability.

The occurrence of nutreous grasses in the Southern zone is confined chiefly to the soil which surrounds the outcropping granite rocks (which are also the areas of rock holes and soaks) and also to the bases of greenstone hills and ranges (usually areas where claypans occur).

In the vicinity of rocks, poison plants (berry poison and box poison) are also often met with.

In the zone of transit *Eucalypti* and *Acaciæ* grow side by side till Southward the former, and Northward the latter, obtain the undisputed predominance.

This zone, chiefly in its Western portion, shows itself most favourable for the development of *Cupressineæ*. The latter grow here to trees of considerable height, and occupy, together with *Eucalypti* (usually mallee) and *Acaciæ (Mulga and Mayol)*, boundary belts between soil derived from accumulative decomposition from one side, and loess or alluvium from the other. Northwards the *Cupressineæ* gradually cease to be seen, and Southwards they decrease considerably in size, and so also does the frequency of their occurrence.

In this zone in the vicinity of rocks the kite poison plant (so called from the shape of its leaf) is of frequent occurrence.

The Northern zone, as already mentioned, is characterised by the predominance of *Acaciæ*. The various species, collectively called *Mulga*, although having differently shaped and coloured flowers, have a more or less uniform aspect.

No doubt a specialist could soon nominally discern the various hygrophile and xerophile species. The camel prefers the former as feed. From bushes of almost equal appearance it will eat the leaves and tops of the one, and leave the other untouched. Closer observation will show a slight difference in such cases.

In the vast mulga areas it would be easier to take the soil and surrounding physiography as guidance for botanical recherche, than floral distinctions as guidance for geological investigation.

Eucalypti are scarce in the Northern zone, and are represented by extremely hygrophile and xerophile species.

The white-barked creek gum, and sometimes also the Morrell gum trees follow water courses in narrow belts for considerable distances, and indicate them hereby from afar. The first attains occasionally large dimensions.

Patches of stunted mallee and desert gum trees occur occasionally on higher situated country, and on sand hills and sand drifts.

The so-called snakewood bush and the corkwood tree are peculiar to the North zone; the former grows chiefly in areas of accumulative decomposition, where the still solid rock lies at no great depth below the surface; the latter usually follows the banks of creeks.

Besides a considerable grass vegetation around rock outcrops and along water courses a flora of very nutritious herbage grows in the extensive mulga flats. During and after wet seasons this herbage sprouts up in the bare, clayish, sandy soil in an incredibly short space of time; but, unfortunately, also it dries up and disappears very quickly if rain keeps off for any length of time.

The occurrence of poison plants decreases as we go Northwards.

Santalaceæ remain more or less constant throughout the interior gold region, and the so-called quondong tree shows the least dependency on soil and climate.

Casuarinaceæ are represented by different species in the North and in the South.

The Currajong tree (*Brachychiton*) becomes more abundant towards the Northern parts.

The saltbush (*Halophytes*) consists chiefly of dense pale green and reddish-green scrubs which seldom reach a height of more than three feet. A very high degree of salinity in the soil is the chief condition for the growth of this vegetation; it occupies, therefore, the wide saline depressions and the shores of the so-called salt lakes. As it retains an almost constant floral character right through the interior gold region from South to North, and also beyond in both directions, it is apparently independent of climatic influences.

V.—DESCRIPTION OF COUNTRY FROM THE "NINETY MILE" TO LAKE CAREY AND FROM THENCE TO CUE.

For about eighteen miles North of the place called "The Ninety Mile," * lacustrine formations, loess strata resulting from accumulative decomposition, and sand dunes are the principal features.

Greenstone cappings and out-cropping massive granite rocks are also occasionally met with.

Further North, a greenstone range, "The Carmichael Hills," rises above the general level of the country and extends for several miles in a North-Westerly direction.

The average height of that range above the sea level might be from 1,300 to 1,400 feet, and about 250 to 300 feet above the level of the adjoining lacustrine flats.

After having passed that country I drew the attention of several prospecting parties to its auriferous character, and I hear considerable gold deposits have been found there since.

Adjoining the abrupt Eastern descent of the Carmichael Range, extends a stretch of lacustrine country, which, about 20 or 25 miles further South, adjoins the "Ninety-mile" Hills from the East.

A few miles further in a N.N.E. direction, this lacustrine stretch continues, till it joins with the great depression within which Lake Barlee is situated. This depression extends from Mount Kenneth to the Pinnacles, and contains, besides the above lake, a chain of so-called salt lakes.

Archæan rocks, carrying occasionally greenstone cappings, rise to the surface at the North-Eastern end of the Carmichael Range; in parts those rocks appear on the surface in a solid indecomposed state, whereas in others, accumulative decomposition has already proceeded to a great depth.

There are a few erosive channels cut into the decomposed stratum.

The solid indecomposed granite rises in some instances through and above the decomposed stratum, and forms hills of considerable dimensions.

The transit from the decomposed into the intact solid rock is gradual.

There are a few rock-holes and native wells in this locality, and by the sinking of soaks a permanent water supply could be obtained.

Within that formation, and at a distance of about 35 miles N.N.E. from the "Ninety Mile," a granite hill rises to a height of about 180 feet above an adjacent salt lake.

The latter occupies here the Lake Barlee depression, and borders the base of the fore-mentioned hill in a Northerly and North-Easterly direction.

Towards the West this lake becomes narrower, whereas in its E.S. Easterly continuation it reaches, in some places, a width of from four to six miles.

About three miles to the North-West from the top of the fore-mentioned granite hill, the lake terminates with two narrow branches.

Older lacustrine beds, rising a few feet above high water line, cause this termination.

Those beds consist of sand grains, cemented by a felsitic and dolomitic matrix; they became covered with neogene subaerial formations, which carry a dense mulga vegetation.

The interruption in the chain of lakes by those higher situated older beds extends from here for about 10 miles in a Westerly direction, and forms a favourable crossing for a road into country to the North, and towards Lake Carey.

Following a Northerly course, flat country with lacustrine and subaërial surface formations is crossed for about four miles, after which a gneissic formation is entered.

First, the surface is chiefly covered by detritus of accumulative decomposition, but after a few miles' travel, signs of hydraulic and æolian denudation are met with.

For about 14 miles Northwards from the crossing of the Lake Barlee depression the country rises gradually, and has at that distance attained already a considerable height above that depression.

Steep banks of water-courses, cut into rotted archæan rocks, attain here a height of 20 feet, and sometimes even rise higher than that.

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* Known as *Goongarrie*.

Rocky terraces, forming a step to higher plains, designate previous higher levels of watercourses and old lacustrine strands.

There is a creek, the bed of which has a precipitous fall of about 25 feet.

The catchment area for the upper portion being considerable, during wet seasons this place must have a magnificent waterfall.

Beyond that fall the watercourse continues Southwards in a narrow channel, cut into the rotted gneiss.

The steep banks of this creek decrease gradually in height, and after about two miles the whole watercourse disappears in a wide sandy flat.

At the time of my visit no water was running over the fall, but there were large quantities of it stored in natural holes excavated in the side, and at the base of the precipice.

In one of those holes (about 6 feet diameter) the water stood 12 feet deep, and two cave-like holes, of large size but partly sanded, also contained large quantities of water.

There are several similar watercourses within this elevated archæan area, and they all terminate in sandy alluvial flats carrying generally a very coarse grass vegetation.

This latter is of more frequent occurrence in the more Northern latitudes, and there also the geological situations are similar.

The country here is apparently well watered, and has a very good grass vegetation.

Gold can be found in some of the creeks, and is probably derived from original deposits, standing in connection with greenstone dykes, which are occasionally met with.

Proceeding in a North-Easterly direction from that locality, which we might name "The Waterfall," the country is partially denuded and strewn with larger debris of quartz and country rock, but alluvial formations are also encountered.

After a three miles' journey, a high quartz blow, the remnant of a large sized lode-outcrop, around which the less resistive country became denuded, is passed; and five miles further on a low massive granite range is reached. The latter extends from N.W. towards S.E.

Potable water could be obtained here by sinking, and grass is abundant.

Beyond the granite hills the country becomes low and flat. The surface consists of soil derived from accumulative decomposition, alluvium and loess; the latter probably overlaying older lacustrine beds.

Twelve miles further travelling in the same North-Easterly direction brings us to a low range of greenstone hills, consisting of feldspar amphibolites with diabase dykes and quartz lodes.

It runs parallel with the previous granite range from S. E. towards N. W.; and auriferous deposits are likely to occur along its extent.

Descending from that low range another lacustrine depression, extending from Lake Austin along Mount Holmes, Mount George, and Mount Leonora, probably also till in the vicinity of the Pinnacles is entered.

Sand dunes, wide flats, covered with a saline vegetation, and salt water pools or their dried-up beds occupy the deeper parts; whereas alluvial sand flats, stretches of archæan country covered with detritus of accumulative decomposition and loess, form the borders of that depression.

The country situated between this and the great Lake Barlee depression is a portion of the great West Australian plateau like the rest of the interior auriferous region, but it is to a certain extent individualised and separated by those gigantic depressions.

Although traversed by greenstone hills and dykes, the enclosed area consists chiefly of archæan rocks. Diorite and fieldspar amphibolite cappings are occasionally found overlaying the gneissic granite.

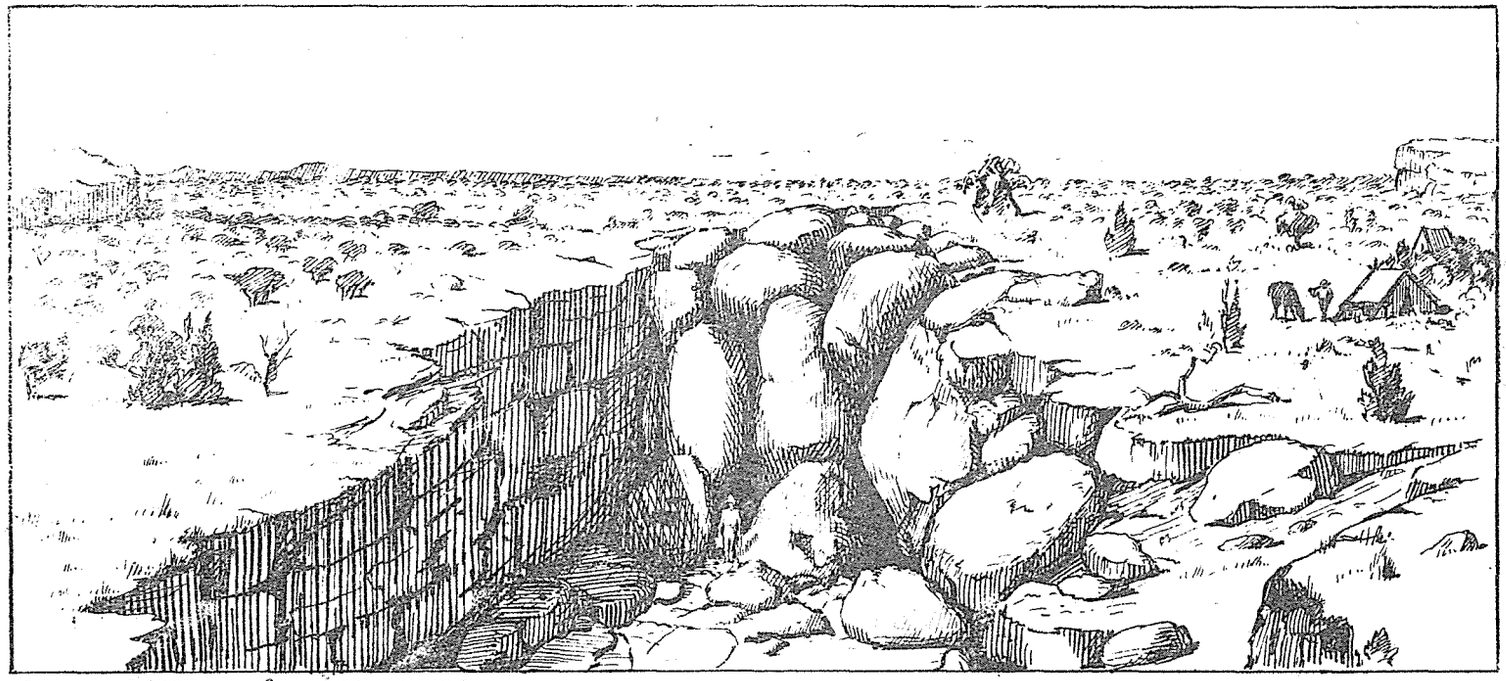
The two depressions are the result of two large breaks in the archæan earth crust, and of subsequent chiefly lacustral erosion.

The enclosed archæan portion has subsided along the Southern break; during and after that subsidence the Northern portion was left in a relatively higher position, whereas the country beyond the Northern break has subsided.

The average width of the country enclosed between the two depressions might be estimated at about 30 miles.

Abandoned native camps, with numerous fire-places and the usual grinding stone, show that the country is inhabited by larger tribes of aboriginals.

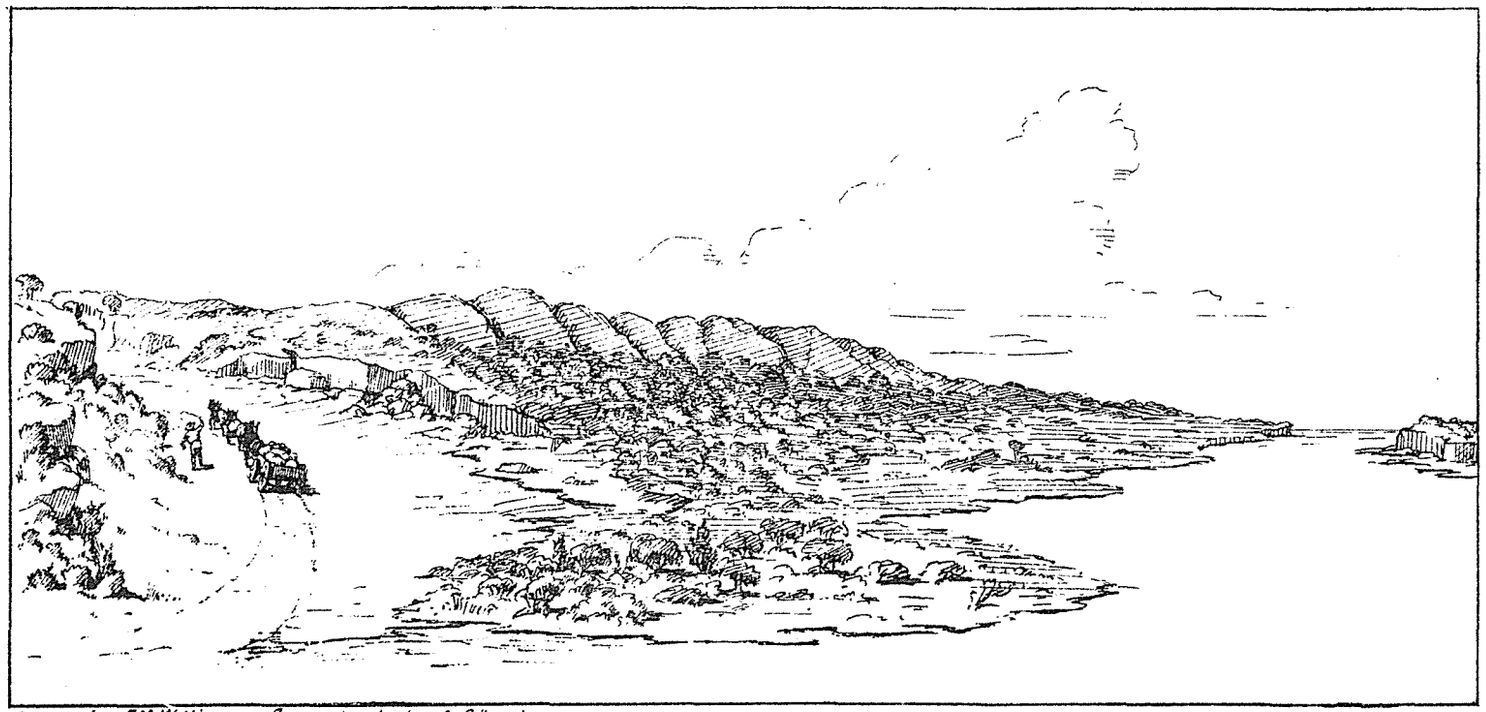
The middle of the second saline depression is about $4\frac{1}{2}$ miles distant from the crest of the last-mentioned greenstone range, and after a further journey of 12 miles across saline, and later on, alluvial and loess flats, but now in a more Easterly direction a large granite-massive is reached.



Drawn by F.M.Williams from sketches by S.Goczel

"THE WATERFALL"

(about 50 miles North of Goongarrie)



Drawn by F.M. Williams from sketch by S. Göczel

Mt Margaret

from South West

The latter has a more or less North-Southerly longitudinal extent, and measures here about five miles across. It forms the water-shed between the former lacustrine depression from the West, and the Lake Carey country from the East. Bare granite hills covered with large boulders rise to a height of about 200 feet above the level of the Western lacustral depression.

The country here is well grassed, and water could be obtained by sinking soaks.

On the Eastern declivity of that granite elevation, lies Bricky Soak. Several wells have been sunk here by prospectors, and water was obtained at a depth from six to eight feet.

This soak is situated in the vicinity of a junction between gneissic granite from the West and dioritic country from the East.

A long stretch of country along that junction, and running more or less North-South, has already been proved auriferous.

The "Red Castle" line of reefs, and the "Goose's Puzzle," are situated along that stretch, and only a few miles North of Bricky Soak.

Rich finds have not been made here, up to the time of my visit, but there exist a number of reefs which in time will offer chances for profitable mining enterprise.

Alluvial and loess flats, with slight elevations consisting chiefly of outcropping schists, extend between this place and Lake Carey.

Neogene, sometimes ferruginous sandstones, line occasionally the beds of a few short creeks, and in deepenings of such sandstone beds water-pools occur.

Lake Carey occupies a third large depression, which although not so well pronounced as the two former, extends for a long way in a North-Westerly direction beyond the present boundaries of the lake.

Altered schists and diorites are the most abundant rocks in the Lake Carey country. Forming very steep, almost vertical lake-embankments, the former show occasionally variegated colouring.

A greenstone range of considerable height extends along the Northern shore of the lake, and of which Mount Margaret forms the highest point.

At the North-Western base of that range several gold-bearing reefs have been already found.

The "Red Flag" and the "Hawk's Nest" are places situated respectively about eight and ten miles in a northerly direction from Mount Margaret, where at the time of my visit, surface and alluvial gold deposits were being worked.

The "Hawk's Nest" was by far the richer place. The gold appears to be derived from primary deposits, contained in the adjoining low hills.

The latter consist chiefly of dioritic schists, through which a number of massive diabase dykes are running. Approaching more or less a North-Southerly course, those dykes are accompanied by, and contain quartz bands, their width varying from a few inches to a foot, and occasionally the quartz is rich in gold.

I drew the attention of prospectors towards those primary gold deposits.

The "Red Flag" lies about three miles to the East of the Hawk's Nest. A quartz hill, formed by the outcrop of a big quartz lode, round which the adjoining country became denuded, forms a prominent feature at this place. Although the quartz of that lode is to all appearances barren, the primary gold deposits, from which the surface and alluvial gold found in that locality was derived, most likely stand in genetic connection with the fissure of that lode.

Alluvial and surface gold is found in several other places, and there can be no doubt that in course of time this district will offer inducements for mining enterprises of more permanent character.

Several creeks, with considerable water pools in some of their deeper portions, and a good grass vegetation, facilitate prospecting in the Lake Carey district.

The country in general is favourable for preserving surface water, and also for intercepting, percolating, and potable underground waters in wells.

Between Hawk's Nest and Mount Flora extends a flat, with partly alluvial and partly subaerial surface soil. This flat is the North-West extension of the Lake Carey depression, and the surface formations cover older lacustrine beds.

Mount Flora is situated at the Northern termination of a low schistose greenstone range, extending towards the South.

Most probably this range is the Northern continuation of the "Red Castle" and "Goose's Puzzle" country.

In the higher portions the schists are altered into a banded ferruginous silicious rock (partly ribbon-jasper).

Mount Flora rises only about 100 feet above the surrounding country, but its declines are very steep.

About two miles and a half North-East from Mount Flora is situated McKenzie's Well. The well shaft is sunk for about 40 feet through dolomitic beds of older lacustrine origin. Situated considerably above the water level of the drainage area, those strata are already leached of chlorides and sulphates; and the well supplies hard, but potable water.

A little further to the West, a junction between paleozoic greenstones from East, and archæan rocks from West, is crossed; the chiefly granitic archæan elevation forming again, as it does further South, the water-shed between the "Lake Carey country" and the country situated South-West of that elevation.

Gneiss-granite rocks appear on the surface, and alluvial formations extend at the base of precipitous, flat-topped elevations. The latter are old lacustral strands. An upper decomposed stratum of gneissic granite has partly succumbed to lacustral denudation.

The feldspar of those rocks has become kaolinised, and the mica altered into a pale talcose mineral substance, whereas the quartz grains have remained unaffected.

Solid portions of granophyre are often found embedded, and quartz veins and lodes traverse occasionally, the decomposed rocks.

Greenstone dykes and cappings are not of rare occurrence.

Fluviatile erosion has in a few places continued the work of the old lacustral waves, and in some of the creeks alluvial gold deposits are found.

About 12 miles distant, in a West of North-Westerly direction from Mount Flora, and on the Cue-Lake Carey track, is situated McKenzie's Rock. This is a large flat granite outcrop, of a massive appearance. Less resistive portions of the same rock, adjoining and above, have decomposed *in situ*; later on the detritus was removed, and the present rock outcrop became exposed.

This and a line of similar rocks crop out in a wide flat valley, eroded into the decomposed archæan strata. Towards North-East the remaining portions of the latter rise in step-form, indicating old lacustral strands.

From McKenzie's Rock, towards South-West, the rise is gradual. At a distance of one mile, and in the above direction, a few insular elevations, with abrupt descents, are met with. They are remaining portions of a denuded upper stratum.

North-Westwards from here the great plateau rises sometimes in terraces (old lacustrine strands), sometimes gradually; and very probably this rise continues as far as the watershed of the Murchison River.

Archæan elevations, usually covered with recent æolian sand-drifts (spinifex plains), alternate with depressions.

Erosive channels and miniature canons are occasionally cut into the upper decomposed strata of the archæan rocks.

Ranges, consisting of paleozoic greenstones, are more dispersed and of smaller extent than in the Southern parts. They occur at some distance from one another, in more or less interrupted parallel belts, tending mostly in a West of Northerly direction.

Lacustrine depressions are here scarce, and in the wide flat valleys neogene alluvium and heavily sanded watercourses occupy the deepest portions. Older lacustrine formations—usually calcareous and dolomitic beds—have here a considerable development. Mostly they are covered by alluvium and loess, but are also found cropping out on the surface.

From portions of those beds, situated above the water level of their area of drainage, sulphates and chlorides were leached; and wells sunk into such lacustrine strata of older date, if the latter are saturated, will supply tolerably potable water.

The tend of the country is here also West of North, and correspondingly valleys and elevations have an average longitudinal extent in that direction.

The great depression, beginning with Lake Austin in the West, and extending from thence in an Easterly direction along Mount Holmes, Mount George, and Mount Leonora, is the general area of drainage for the country situated to the North-West.

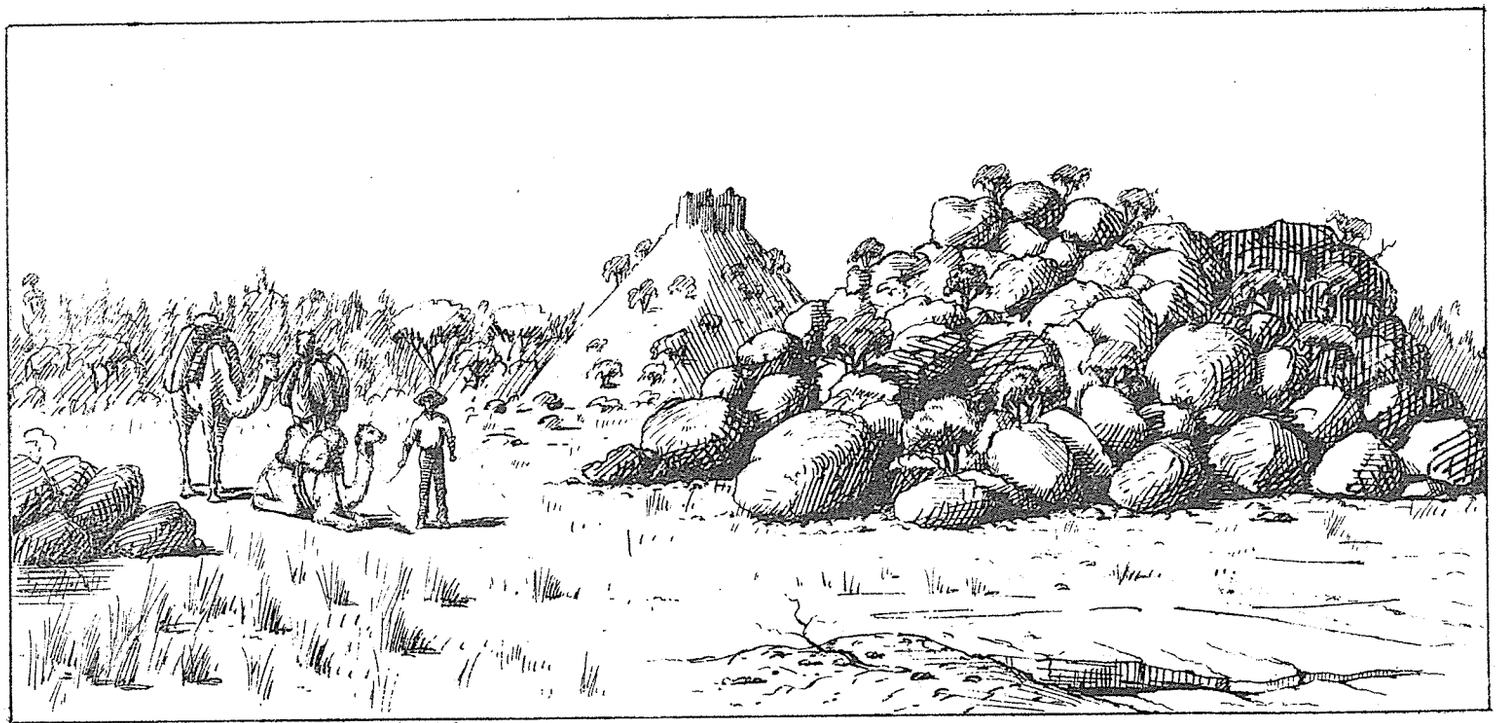
The watershed between this and the Lake Carey depression extends from McKenzie's Rock in a North-Westerly direction, Lake Carey, Lake Darlôt, and Lake Way forming the principal areas of drainage for the meteoric waters falling Eastwards of that watershed.

Westwards of the latter a number of creeks, running more or less in a parallel direction towards the South, extend sometimes for miles, till they disappear in some sandy flat. They are generally heavily sanded, and in some of their depressions water may be obtained by sinking a shallow hole into the sandy bed. Waterpools of considerable depth occur also occasionally along their course.

Drawn by F M Williams from sketch by S Göczel

Gum Creek

Cue – Lake Carey Track



Drawn by F.M.Williams from sketch by S.Göczel

"THE LICHTHOUSE"
Cue – Lake Carey Track

The most of those creeks originate at the base of old lacustrine strands, which are eroded into higher situated rotted archæan rocks.

In the middle course of some of those creeks the banks decrease in height, and unmistakable signs of heavy and widespread floods give proof that the meteoric precipitations in this portion of the country attain occasionally a torrent-like intensity.

The white-barked creek gum tree and morrell are usually found growing along the banks of those water-courses. The height and verdure of foliage of those eucalyptus trees surpass by far that of the surrounding mulga scrub, and produce hereby very conspicuous lines, distinguishable sometimes for miles. (Plate 3.)

Some of such creeks follow the junctions between archæan country and paleozoic greenstone formations.

In more Southern portions of the auriferous reigon, salt lakes or lacustrine flats usually occupy similar geological situations. The difference in this case is due to greater absolute height above the area of drainage, and to an increased abruptness of meteoric precipitations.

In consequence of the same causes, easily soluble compounds are already removed out of the strata and rocks of higher levels; therefore meteoric waters, percolating through, or stored in completely saturated portions of strata already leached, are usually potable.

Proceeding Northwards from McKenzie's Rock, similar flat rock outcrops and a good grass vegetation continue for about four miles.

The soil in the vicinity of those outcrops is partly detritus, of accumulative decomposition, and partly alluvium.

All along the above-mentioned distance the country rises; the archæan elevations are usually covered with æolian sand-drifts, and assume gradually the so-called "spinifex plain" appearance.

Twelve miles North of McKenzie's Rock, a gneissic area arises above the surrounding high plains, covered with drift sand.

In this area denudation proceeds, and its vegetation is different from that of the surrounding sand plains.

The flora of this and of similar surface formations might be regarded as a stage of transit between the more hygrophile flora, of lower situated archæan areas, with a soil derived from accumulative decomposition and the xerophile flora of the elevated sand plains.

The last-mentioned elevation is situated in the water-shed of the Lake Carey depression, and a further progress Northwards leads into a North-Westerly extension of the latter.

After a descent for about four miles, through spinifex sand-plain, the North continuation of the junction, between the water-shed forming gneissic-granite country from the West and paleozoic greenstones from the East, is crossed a third time.

Quartz hills, formed by the outcrops of wide quartz reefs, rise above the mulga scrub and are visible for some distance. The surface is strewn all round with quartz fragments, and a creek takes here its commencement. Continuing a Northern course for several miles, it disappears in a wide loess flat. The few waterpools found in it are not large, and not likely to last long after the rain that filled them has ceased.

The watershed takes a North-Westerly course, and joins, a few miles South-West of Lake Darlôt, an extensive archæan massive.

The average height of this massive might be estimated about 300 feet above Lake Darlôt, and the latter, according to Mr. Wells, surveyor to the Elder Exploring Expedition, lies 1,825 feet above sea level.

Mount Doolette is a prominent elevation in the Eastern portion of that massive. Its Eastern base is touched by a salt lake depression which tends in a Northerly direction towards Lake Darlôt.

In the middle of that depression long and narrow belts of old lacustrine beds rise several feet above the present level of saline flats and lakes. A forest vegetation of eucalyptus trees distinguishes those belts from afar.

In searching for water in a creek at the Western base of Mount Doolette, I came across an old meeting place of the aboriginals. Over an area of about half-an-acre the stones were cleared from the surface and piled into about 25 or more larger and smaller heaps. Tracks, stones put into forks of trees, old camping places and huts, show that the country is inhabited by natives.

At the time of my visit this part of the country was very dry, and all the waterholes were empty. Several trials of the ground showed that there had been no rainfall for a long time, and that a rain which had fallen five days previously at McKenzie's Rock had not reached so far Northwards.

In consequence of the exceeding dryness of the country I gave up my intention of proceeding towards the Northern part of the Murchison Goldfield, and decided instead to reach the central district first.

In order to obtain water I was obliged to go back for 40 miles to some water holes which I had previously passed.

After having replenished the water bags, I proceeded towards a rocky elevation situated about 42 miles North-West of Mount Flora.

On the evening of the 3rd of August I had pitched my camp about three miles South-East from that rocky elevation. It was a cloudless night. My attendant and I were near the camp fire, when, pointing with his hand towards East, he made a remark about a flash of light. Turning at once in the indicated direction I could see nothing, but at the same time a loud booming sound was heard. This sound resembled so much that caused by the detonation of large charges of explosives in rock blasting, that for a long time I thought that some prospectors were somewhere near at work, a supposition made more probable through the vicinity of formations which, most likely, are auriferous.

Only later, and a good while after this, having heard once more similar sounds, I remembered the occurrence of dry thunder storms in the arid regions of Australia. Considering the flash of light seen by my companion, it can be taken as almost certain that this noise was caused by a sub-aërial electric discharge.

The elevation previously referred to consists of altered schists. It rises abruptly to the height of about 60 feet above the adjoining country. A few creeks extend from thence in various directions, but for short distances only.

Similar abrupt rises, but consisting chiefly of decomposed archæan rocks, and sometimes arranged in a terrace form, extend along the distance from this place to Cue. They are old lacustrine strands. The waters of the lacustrine depressions situated to the South have once reached to that height.

Viewed from a distance, a line of old greenstone hills and ranges apparently accompanies the great depression from Mount Leonora to the centre of the Murchison Goldfield, and four minor greenstone belts, branching from that depression, in a North by Westerly direction are crossed on the way from Mount Flora to Cue.

The geological conditions, which are very similar with those where rich gold deposits have been discovered, have already attracted the attention of a few prospectors, and it is very probable that good gold finds will be made along those old greenstone belts.

The track approaches more or less the old strand-lines, and crosses a number of creeks, as already described.

Within the old lacustral area, portions of the archæan upper stratum have resisted denudation, and now form isolated elevations with very steep declines. They were actually islands, and their declines are also old strands.

Some of the prominent isolated elevations are very picturesque, and offer themselves to the traveller as welcome objects for orientation. They occur generally in localities where the underlying archæan stratum is more of a massive granitic nature, and more resistive against decomposition. Flat rock outcrops, with so-called "namma holes," are occasionally found in the vicinity of such isolated elevations.

A direct line from Mount Flora to Cue measures about 260 miles, and the track between the two places covers about 284 miles.

My deviation towards Lake Darlôt took me away from the track from McKenzie's Rock to Marshall's Pool, that is for a distance of about 70 miles.

The track is good, and was, when I passed along, well watered. By the sinking of a few wells and tanks a permanent water supply along it could be secured without a large expenditure.

As already stated, the track extends mostly below and along old lacustrine strands, and the greatest part of it passes over loess covered old lacustrine beds, and the rest, excepting the four greenstone belts, over archæan strata and alluvium.

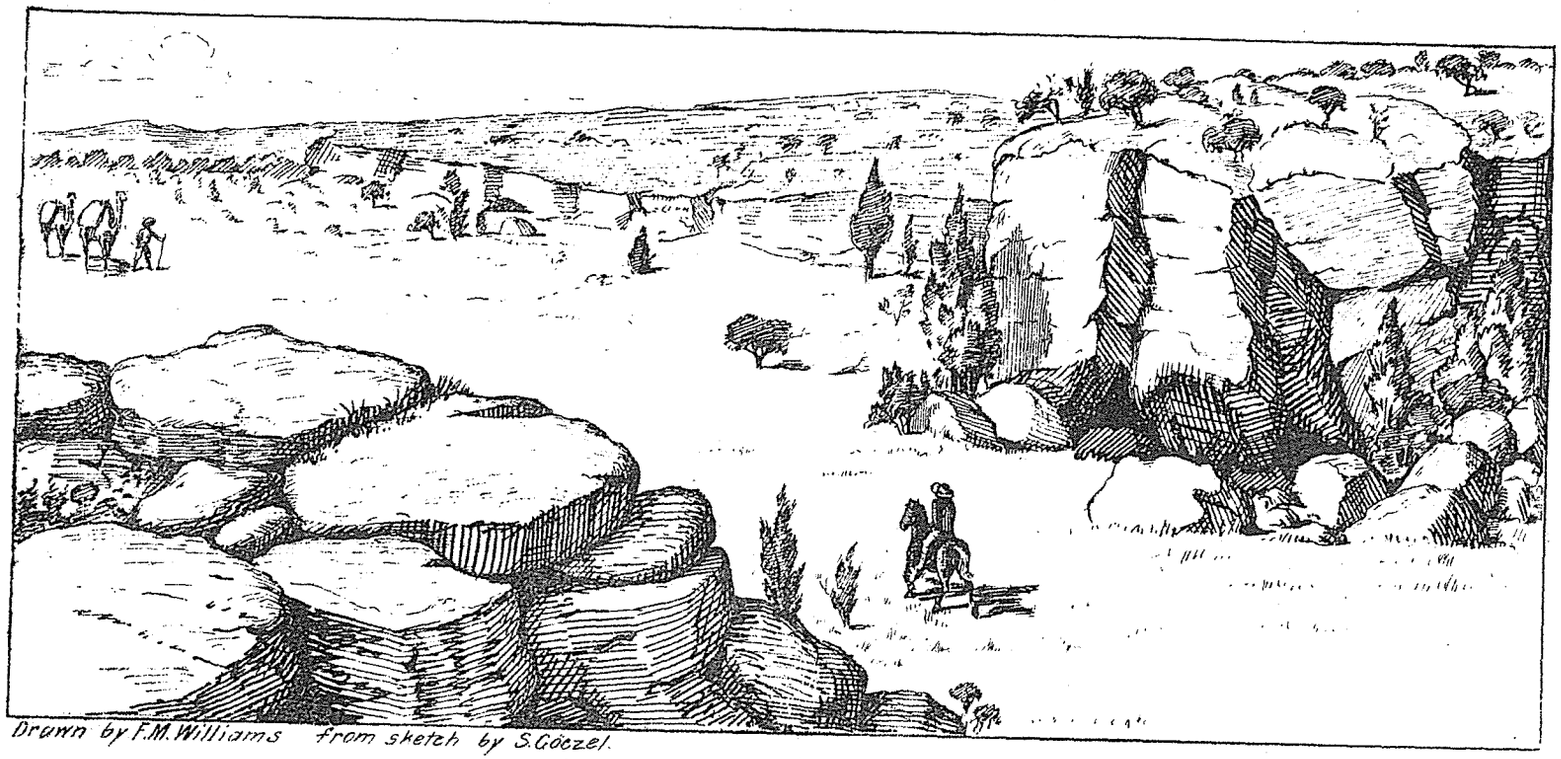
The flora along the track remains more or less constant, its chief feature being the mulga scrub; and it also may be mentioned that emus, turkeys, parrots, kangaroos, and dingoes are here more often met with than in the South-Eastern portion of the auriferous region.

VI.—THE MURCHISON GOLDFIELD.

The general description of the geological features of the interior gold region applies also to the area of the Murchison Goldfield.

Zones of contact between archæan strata and paleozoic greenstones contain here also, as well as in the rest of the interior gold region, the largest and most important auriferous ore deposits.

The beds of Lake Austin and Lake Annean are not situated at a much higher level above the sea than those of the more Southern and South-Eastern salt lakes.



Drawn by F.M. Williams from sketch by S. Goczel.

"DESERT GATES"
Cue – Lake Carey Track.

The country around the saline depressions here rises in larger masses, and to a greater height above the respective areas of drainage, than in the South, and large areas of water-conducting and water-retaining strata are already leached of easily soluble mineral compounds. Those strata, if tapped by wells, supply therefore tolerably potable water.

Hydraulic denudation has here wider fields to act upon, and alluvial features have therefore a greater development than in the South.

Old lacustrine strand-lines, situated at from 100 to 200 feet above the water-level of the respective drainage areas, and channels eroded through barriers, which, in form of paleozoic greenstone ranges, stretch across archæan depressions, lead to the conclusion that during the time when the waves of a shallow paleozoic ocean were stretching over the Southern portion of the interior gold region, and only here and there a few volcanic islands were rising above its level, a very large Northern portion was already dry land.

The ocean was receding South-Eastwards, and long and narrow marine ingressions were reaching as far as and beyond the present gold-mining centres of the Murchison Goldfield. They followed the breaks and depressions in the archæan earth crust.

In course of time those marine ingressions became separated from the gradually receding ocean and became transformed into inland lakes.

The flow of volcanic magma across the beds of such marine ingressions, and its formation into physical barriers, were the chief causes for such separations; although the formation of estuaries and a general secular upheaval might also have produced similar effects.

The old strands usually cut into an upper decomposed archæan stratum show successive levels of receding inland lakes.

Along zones of contact with paleozic greenstones the feldspar components of the archæan rocks have generally undergone the process of kaolinisation, and the rocks were thereby rendered a great deal less resistive against denudation. Therefore old lacustrine strands and strand-lines have found their greatest development in the vicinity of such contact zones.

Certain regularities in the occurrence of the various breaks in the archæan earth crust could be explained by investigating and following up the traces of the dynamic forces which were once active in this region.

The distribution of the various auriferous areas along those breaks opens also a wide field for specialistic geological investigation.

The opening of the gold deposits within the Murchison Goldfield, although not so difficult as in some of the other parts of the auriferous region, has had to overcome enormous obstacles.

The hardy pioneers who have charged themselves with that task have carried it out successfully. Their manly spirit of enterprise, and the work of their strong arms, has placed the permanency of the field beyond all doubt, and now it depends chiefly on those who are directly concerned in special gold mining ventures if those shall remain, for the future, speculative and risky concerns, or if they shall become systematically conducted, remunerative enterprises.

The work performed, although of not a great value for further systematical development, has led to very gratifying results. It gave insight into the nature and richness of the various gold deposits, and it has supplied data concerning facts, and expressed in figures, which may serve to a great extent as reliable basis for further enterprise.

By this it must not be understood that estimates and valuations of gold deposits can be made by simply taking the width and available length of a lode or reef, and by attributing to the cubic contents of same the average yield of the first fifty, hundred, or even thousand tons of crushed stone.

It must be remembered that the workings in the Murchison mines have not extended far below the respective water levels, and that productive work has been performed almost exclusively above those levels, where the gold usually occurs as free gold.

Many of the leases were held by small working parties, who, with very little capital, and with hardly any outside support, had to keep their mining concerns going. Gold had to be obtained immediately, systematical proceeding was out of the question altogether, and only shoots which could supply dollying stone were searched for and followed as far as possible. In many instances the rich auriferous stone broken during that period of specimen hunting, and the rich dolly tailings, have formed the first parcel of stone which was submitted to battery treatment.

Estimates based on the fore-mentioned supposition would be, therefore, in many cases, erroneous and misleading.

In conjunction with a due geological consideration of the surroundings, and a careful investigation of an opened up portion of a gold deposit, the first large crushings make a prominent factor in the

calculations of an estimate; and a rough general estimate of the field and its mines executed on such lines opens already bright views for the future of the gold-mining industry on the Murchison goldfield.

Before the railway communication with the coast becomes completed, one more crisis will have to be faced by many of the mines in this field.

Without efficient pumping and hoisting machinery it would hardly be possible to extend the workings and to follow the richer shoots below the respective water levels.

The areas within the reefs and above water level which contain auriferous stone, payable *under present circumstances*, have a limited horizontal extent, and in most cases will become exhausted before the Geraldton-Murchison railway can be completed.

To cart efficient machinery at the present time would mean a great waste for which the small gain of time would be an insignificant recompense, and to which, from a point of economical view, even the idleness of the mines would be preferable.

Considering the nature of the auriferous deposits, and the alteration of the circumstances which must take place when the rail communication with the coast is effected, it can be safely calculated that the areas within the lodes which contain payable stone will increase on an average to 20, and perhaps even 30 times their present extent.

To continue shaft sinking beyond a certain depth without machinery is not possible, and that depth has in many cases already been or soon will be reached.

To erect machinery before completion of the railway would be injudicious, and the time gained by doing so would be only short. To raise stone with windlass and bucket which, only by employment of machinery, and under the expected altered circumstances can be considered as payable, would not only require large capital outlay, but would also mean the payment of a greater value for the produced gold than its recognised value.

Besides this the scarcity of suitable mining timber within this goldfield acts also as a great drawback to its present progress.

The dry country formations above water-level in most cases have stood, and stand sufficiently safe, and do not require much timber in the workings; but with a further downward progress the requirement for that commodity increases, and as matters are standing now, even rich mines, with pumping, hoisting, and hauling machinery already erected, find it very difficult to cover their requirements.

This difficulty will only be overcome after the completion of the railway.

At the present time, in many of the mines within the Murchison Goldfield—although they may be very valuable—a continuation of work would only mean waste of national wealth and energy.

As the only reasonable expenditure of work in such cases would be the possible preparations required for the execution of future working plans, the granting of exemptions from the labour conditions after those preparations are executed would be a step worthy of consideration.

Having visited the various mining centres of the field (excepting the Yalgo District), and inspected the prominent ore deposits, I venture to say that under systematical and economical management, the auriferous reefs and lodes of this field are capable of supplying for many years a daily average output of 700 to 800 tons of payable gold-bearing stone, and judging from the preparatory measures already taking place, it is most probable that this output will be attained, if not surpassed, at the end of the second year after completion of the railway.

No doubt with the increasing depth of the mines, the energy to be spent in raising ore will gradually increase, but from the nature of the gold deposits, the development of mechanical appliances, and the progress in their employment, it can be safely hoped that such an output will maintain itself for a long number of years.

1.—CUE AND DAY DAWN.

Northwards from the Lake Austin depression, and rising as we proceed in that direction, extends the Cue-Day Dawn basin, in which the two central townships of the Murchison Goldfield, and also the principal mines belonging to those two places, are situated.

Numerous quartz reefs, and also dykes striking in various directions, but most of them having a Westerly underlay, accompany a large break through the country.

This break has a North-Easterly course, and passes immediately to the West of the Cue Township. It follows more or less a junction between gneissic granite from the West, and altered schists from the East.

For considerable distances on both sides of the junction, and chiefly along lodes and faults, the country formation has suffered alteration.

In the archæan granite the feldspar became kaolinised, and the mica (biotite), by removal of bases and hydration, changed into foliated talk.

NANNINE

LAKE ANNEAN

YAGAHONG

Star of the East

CUE

DAY DAWN

L. AUSTIN

MAINLAND

ISLAND

WEST Mt MAGNET

(WARRAMBOO)

EAST Mt MAGNET

Lighthouse

Mt HOLMES

LAKE DARLOT

Mt DOOLETTE

Quack Blow

Marshall's Pool

Rock Hole

Mt FLORA

Well

Hawk's Nest

Red Flag

Mt GEORGE

Mt MALCOLM

Mt LEONORA

Conset's Puzzle

Red Castle

Bricky Soak

LAKE CAREY

Warden

GOONGARRIE

COMPASS TRAVERSE & GEOLOGICAL SKETCH

From Goongarrie to Lake Carey & Lake Darlôt, thence to Cue

by **S. Göczel**

Geologist &c.

1894-5

10 0 10 20 30 40 50

English Miles

DEPt OF MINES

WESTERN AUSTRALIA

Hon. E.H. Wittenoom M.L.C.

Minister for Mines

Archaean. *Gness, Gneissic Granites, Granophyres, Mica schists, Talcose schists, Quertzites, & Genuine Amphybolites.*

Palæozoic. *Massive & Schistose Greenstones, (Diorites, Diabases, Gabbroes, Feldspar-Amphybolites, & Diabase schists.) Felsite, Porphyrics.*

Mesozoic & Cœnozoic. *Sedimentary beds, Loess, Subaerial & Alluvial features.*

DRAWN ON ZINC BY A.H.B

Geological Sketch Map
Shewing the
Interior Auriferous Region
of
Western Australia
by
S. Göczel
Govt. Field Geologist
Dept. of Mines
Western Australia
Hon. E. H. Wittenoom M.L.C.
Minister for Mines
Archaean
Palæozoic Greenstones (Massive & Schistose)
Palæozoic Sedimentary rocks
Mesozoic & Cænozoic
MURCHISON
YALGOO
G.F.
YILGARN
G.F.
COOLGARDIE
G.F.
EAST
COOLGARDIE
G.F.
DUNDAS
G.F.
HAMPTON PLAINS
Watershed of the Murchison
Nannine
Cue
Lake Austin
Lake Moore
Lake Barlee
Lake Giles
Lake Seabrook
Lake Carey
Lake Lefroy
Lake Deborah
Lake Brown
Lake Cowan
Southern Cross
Hopes Hill
Burracoppin
Meckering
Doodlekine
Mt Churchman
Mt Jackson
Koolyanobbing
Coolgardie
Kalgoorlie (Hannans)
Kanowna
Broad Arrow
Mulgarrie
Menzies
Mt Margaret
Mt Malcolm
Mt Leonora
Dundas Hills
Norseman
Fitzgerald Peaks
Pk. Charles
Pk. Eleanora
Esperance
Esperance Bay
C. le Grand
Doubtful Island Bay
Hood Pt
C. Knob
C. Riche
King George Sound
Bald Head
Peak Head
Eclipse Is.
C. Vancouver
Cranbrook
Stirling Ra.
Mt Madden
Mt Ridley
Mt Heywood
Mt Burdett
Mt Holland
Mt Hampton
Parkers Ra.
Cosmo Newberry Hill

The schistose paleozoic greenstones (chiefly feldspar-amphibolites) were altered into a kind of chloritic schists.

Immediately to the East of the Cue Township a greenstone range rises to a height of a hundred or more feet above the level of the streets, and at a short distance to the North several flat topped isolated elevations, with steep declines, attain a height of from 30 to 60 feet above the general surroundings.

Those isolated elevations, or "table tops," as they are locally called, are remnants of an upper archæan stratum, the bulk of which was removed by lacustral denudation. At one time they were islands in an extensive inland lake, the old strands of which are often met with in the surrounding country.

The "table top hills" consist of rotted gneissic-granite. They owe their resistiveness (which has preserved them during the attacks of the lacustral waves) chiefly to quartz-lode formations, which, with their branches and veins, extend along and partly also through the hills.

Depressions in the rotted gneissic granite on the top of the hills contain remnants of conglomerate and sandstone beds which, although no paleolontological proof exists, most likely are of Cambrian age.

The reefs which are situated to the West of the main break have, as country formation, more or less decomposed gneissic granite; and those situated to the East, altered schists.

Some of the lode fissures within the first named formation are very wide, and contain besides bands of auriferous quartz, large gangue formations, consisting chiefly of talcose kaoline.

The latter is apparently derived from the rotted granite country rock, and was carried into the fissures in mechanical suspension by percolating waters.

On the contrary the seams and veins of auriferous quartz were chemically deposited.

This class of lodes can be ranked under the compound lodes.

The intersection of reefs with cross reefs and cross fissures plays here also an important rôle in the occurrence of gold shoots. The shoots in lodes which have archæan rocks as country formation, have usually a larger horizontal extent within the lode than shoots in lodes within paleozoic greenstones, although phenomenal richness goes more with the latter class.

The mines around Cue and Day Dawn have steadily advanced since the first gold discoveries here were made, and the work accomplished, and the results shown so far give full promise of a prosperous and permanent gold production, which for years to come will be on the ascendancy.

WATER SUPPLY WITHIN THE CUE-DAY DAWN BASIN.

The rain precipitations within the "Cue-Day Dawn" basin are mostly absorbed by the porous soil, and the subterranean percolation chiefly follows lodes and faults in the country.

The Lake Austin depression is the area of drainage for this basin, as well as for most of the surrounding country. The country situated North of the Western portion of the Lake Austin depression rises as we proceed Northwards, and the percolating waters of the "Cue-Day Dawn" basin have therefore a Southern outfall.

The country adjoining reefs, faults, and fissures within that basin has been generally found decomposed or altered as deep as shafts have already been sunk.

With the kaolinisation of the feldspars in the archæan rocks, and the alteration of amphibolites into chloritic schists, easily soluble mineral constituents of the country were replaced by more resistive ones, and the rocks, after alteration or decomposition, became far more permeable for water than they were in their primary state.

During the process of decomposition or alteration, large quantities of mineral matter were removed in solution, and as the rocks have retained their original texture, the storage capacity of the decomposed country has necessarily largely increased. In portions of country not traversed by lodes and fissures the decomposition does not reach a great depth, but the depth of the decomposed stratum increases in approaching the next lode, fault, or fissure. Decomposition reaches the greatest depth along lodes and fissures, and towards such the meteoric waters of all adjacent area percolate.

The subterranean physiography of the surface of the indecomposed and still solid country rock prescribes the movements of the percolating waters until they reach a level of complete saturation, and from thence the outfall towards the drainage area decides the further movement.

The principal subterranean conduit of the "Cue-Day Dawn" basin most probably extends along the contact between the gneiss-granite and the schist country. The various lodes and fissures, being more or less connected with this conduit, act in a similar way as the branches do to a main river.

The Cue-Day Dawn conduit is, in all probability, joined by subterranean influxes, which drain from the extensive greenstone country situated West-South-West of Cue. This junction occurs not very far to the South of the Day Dawn mine.

The water obtained in shafts sunk within the depression, which stretches to the South-West of Day Dawn township, has been found very brackish and salt; whereas the subterranean water of the Cue-Day Dawn basin, North of that depression, although more or less brackish, is still potable.

In the following localities, within the Cue-Day Dawn basin, the water level has been reached at the following depths:—

At the Cue Town Wells at	...	...	...	126	feet
„ Maori Mine	...	...	...	125	„
„ Lily „	...	...	...	116	„
„ Lady Forrest Mine	...	...	...	94	„
„ Cue Victory „	...	...	...	40	„
„ Kinsella „	...	...	...	43	„
„ Trenton „	...	...	...	55	„
„ Emperor „	...	...	...	45	„

In all but the two last named the water obtained is potable, whereas in the shafts of the Emperor mine it is already a concentrated salt solution.

In comparing the surface altitudes of the localities where those shafts were sunk, it appears that, within the Cue-Day Dawn basin, the variations in the absolute heights of the planes of complete saturation are only slight.

The surface area of the Cue-Day Dawn basin, roughly estimated, will measure about 20 English square miles, and the water requirements within that area will, in the near future, increase at an enormous rate.

No doubt, with the rapid growth of the two mining towns, the development of the numerous mines, and the erection of the necessary gold extraction works, a rapidly increasing drain on the subterranean water stores of this basin will take place; and it becomes a most important and urgent question, to decide to what extent it is possible to draw from that reservoir without damaging the supply, perhaps for numbers of years.

A satisfactory answer to that question could only be deduced from a geological survey of the basin, and from the results of meteorological observations obtained in the district during previous years. Besides that, it would be necessary to ascertain, experimentally, the storage capacity of the principally concerned rocks; how much of the absorbed water will drain away under the influence of gravity; what quantity will be retained by capillary attraction; and also the time required by a certain quantity of water for passing through a certain distance of the permeable rocks under varying pressure.

At the present time I am inclined to take the view that the main and branch conduits containing the potable subterranean waters of the Cue-Day Dawn basin stand in communication with each other, and also with the salt waters of the Lake Austin depression; the outfall of the former towards the latter being caused less by features of impermeable rocks than by an exceedingly high evaporation, which necessarily must take place within the lacustral area.

If, in supposition of the above, excessive pumping should be carried on within the basin, the water level would gradually become lowered. If the general rest level within the basin should recede below the water level of the Southern saline area, the latter would be laid under contribution.

The consequence of this would be that the drawn supply of potable water in the subterranean reservoirs would gradually become replaced by salt water.

Let us take into consideration the less likely case—that the water stored in the pores of permeable rocks within the Cue-Day Dawn basin occupies one or more reservoirs, separated from the Southern saline depression by some impermeable stratum or strata. Then the amount that could be drawn without reducing and finally exhausting the stored quantity would become limited by an average of the annually absorbed rainfall.

As long as the two townships (Cue and Day Dawn) are dependent on a water supply drawn from that subterranean reservoir, it will be advisable for their Municipal Councils to keep the above facts in view.

Sooner or later, with the increasing depth of the mines, and also with the increase of population, the water supply for domestic use will have to be drawn from outside the Cue-Day Dawn basin. Fortunately there are subterranean stores of potable water within a reasonable distance.

To avoid unnecessary friction between the numerous mines situated within the area of this basin, it would be advisable to frame and adopt suitable Water Supply Regulations.

As the most important points of the Cue-Day Dawn country are already geodetically fixed, and as most of the shafts in the concerned localities will by this time have reached the water level, a geological survey, with a view to the water supply, could easily be effected.

Name of Mine.	No. of Lease.	Area a. r. p.	Situation.	Course of Reef or Lode.	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Lady Mary ...	110	8 0 0	North of and in the vicinity of Cue	N.S.	About 10ft. ...	About 45° West	Rotted gneissic granite	Main shaft, following the reef on underlay, 216ft. South shaft, 70ft. South of former, on underlay, 145ft. North shaft, 20ft. North of main shaft, on underlay, 50ft. Drive at the 145ft. level connecting South and main shaft, and extending 70ft. North along the reef. Drive connecting the main and North shaft at the 45ft. level.	The reef is a double lode, with two quartz seams following the walls, and a middle portion, consisting of talcose kaoline. The water level was reached in the main shaft after 213ft. sinking on the underlay. Water potable. At the time of inspection the owners were stoping from the 145ft. level upwards, and to both sides of the main shaft. From the first crushing of 50 tons of stone 163oz. of gold were obtained, and about 200 tons of stone waiting treatment were at grass.
Lady Mary, South	157	12 0 0	South, and adjoining the former	More or less N.S.	Formation on surface about 27ft. Quartz, about 18″	About 45° West	Rotted gneissic granite	Main shaft, following the reef on underlay, 94ft. Several shallow prospecting shafts and drives.	This mine is working the Southern continuation of the Lady Mary lode, and the owners were expecting to cut the Cue I. lode within the area of their lease. From the first 20 tons of stone crushed 57oz. of gold were obtained.
Cue I. Proprietary	203	12 0 0	East of and adjoining Lady Mary and Lady Mary, South	About N.N.E.	About 4ft. ...	About 40° West	Rotted gneissic granite	Main shaft (vertical), 50ft. deep. North shaft (vertical), 50ft. deep. Drive on 50ft. level connecting the two shafts 100ft. long. A new water shaft, with the expectation of cutting the reef at a depth of 150ft., started.	The first 339 tons of stone crushed gave an average of 2oz. 10dwts. of gold per ton.
Rising Sun ...	60	12 0 0	North of and adjoining the Cue I.	Main lode about N.S., besides two other lodes	Main lode about 3ft.	About 45° West	Rotted gneissic granite	Main shaft, partly on underlay, 50ft. deep. Three prospecting shafts. Drive at 30ft. level extending for 100ft. North of main shaft.	The main lode is most probably the North continuation of the Cue I. lode. The first 100 tons of stone crushed gave 213oz. of gold. Previously about 150oz. of gold were obtained by hand-dollying. About 200 tons of stone waiting treatment were at grass.
Commonwealth	201	5 2 15	About 1½ mile N.E. from Cue	Main reef about N. & S.	About 18in. ...	About 30° West	Rotted gneissic granite.	Vertical main shaft 50ft. deep. Underlay shaft 130ft. Another vertical shaft sunk with the intention of cutting the Golden Stream reef 70ft. deep.	In places the reef widens considerably, and contains beside quartz, talcose kaoline. The first 40 tons of stone crushed gave 250ozs. of gold. Previously 43ozs. were obtained by hand-dollying. About 60 tons of stone were still under treatment.
Golden Stream ...	208	5 0 37	East of and adjoining the Common Wealth.	E. & W.	From 6in. to 5ft.	About 30° North	Rotted gneissic granite	A vertical shaft 75ft. deep, cuts the reef at the 70ft. level. Several prospecting shafts.	The first 87 tons of stone crushed, gave 1oz. 12dwts. 16grs. gold per ton. Previously 15ozs. were obtained by hand-dollying.
Mount Murchison	211	12 0 0	About 1 mile N.N.E. from Cue	Several branches of reef extending through a table-top hill			Rotted gneissic granite	Several drives in a table top hill.	The first 12 tons of stone crushed gave 1oz. 5dwts. gold per ton. The lode of which the branches extend through, and are worked in the table-top hill, most probably continues downwards further North of the hill; an intervening portion of it with its adjoining country being completely denuded.
Emanuel	210	6 0 0	East of and adjoining the Mount Murchison	Similar to Mount Murchison					Shoots of rich dollying stone.
Maori, formerly Cue	229	18 0 0	½-mile N.N.W. from Cue	West of North	5ft.	67° West ...	Rotted gneissic granite	Main shaft 150ft. deep, with 25ft. water in it.	This mine has a small Otis crushing plant. 250 tons of stone from a shoot gave an average of 2oz. 2dwts. of gold per ton.
Campania... ...	219	6 0 0	About ¾-mile N.W. from Cue	N.W.	2ft. 6in.	Steep S.W. ...	Rotted gneissic granite	Main shaft 90ft. deep. A shaft north of former 25ft. deep. Drive at 60ft. level from main shaft 35ft. along reef.	About 150 tons of auriferous stone were at grass and in some of the pieces coarse gold was visible.

CUE—*continued.*

Name of Mine.	No. of Lease.	Area	Situation.	Course	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Anglo-Saxon ...	220	6 0 0	About ¼-mile N.W. of the Campania	More or less N., S.	1ft. 6 in.	About 65° West	Foot wall rotted gneissic-granite, hanging wall schistone greenstone	Main shaft 74ft. deep Several prospecting shafts, the deepest of them 85ft.	The first crushing (50 tons) gave 2oz. 15dwts. of gold per ton of stone. About 80 tons of auriferous quartz were at grass.
Lily	119	6 0 0	About ¾-mile West from Cue	25° East of North	2ft.	About 75° West	Rotted gneissic-granite	Main shaft 116ft. deep (water-level). South shaft 50ft. deep.	The following are the results from the first three crushings : 5 tons of stone gave 16oz. 15dwts. gold. 50 „ „ „ „ 142 „ 0 „ „ 8 „ „ „ „ 56 „ 0 „ „ About 200 tons of auriferous stone were at grass.
Francis Reward...		12 0 0	About 1 mile West from Cue	N.N.W.	2ft.	Very steep S.S.W.	Rotted gneissic-granite	Main shaft 140ft. deep. Two drives, one at 50ft. and the other at the 110ft. level.	This mine has an Otis crushing plant. About 200 tons of stone from the mine were crushed. At the time of my visit crushing for other mines was carried on.
Lady Forrest ...	335	12 0 0	About 1¼ mile South-West from Cue	Two parallel reefs E., W.	Northern reef on outcrop 12ft., Southern reef at 90ft. level 18ft.	About 50° South	Massive diorite	Main shaft (vertical) between the two reefs 110ft. deep. Drive across the Southern reef at the 90ft. level.	Some of the stone showing coarse gold. The water coming into the shaft at a depth of 95ft. is fresh and less hard than in any of the shafts around Cue.
Kangaroo...	154 294	12 0 0 6 0 0	About 3 miles West of North from Cue.	30° East ...	About 2ft. ...	50° West. ...	Gneissic granite...	Main shaft, 130ft. on underlay, has reached the water-level. Air shaft, also on underlay, 82ft. deep. Vertical shaft sunk on a cross lode 90ft. deep. 250ft. drives extending principally along the reef on the 80ft. level. Drive from the vertical shaft, 90ft. level, 45ft. long.	About 400 tons of auriferous quartz at grass. The mine manager expects an average yield of 1oz. 5dwts. of gold per ton from it. Pumping and winding gear was in course of erection.
Leviathan ...	183	6 0 0	South of and adjoining the Kangaroo.		From 3ft. to 5ft.				These leases extend over the Southern continuation of the Kangaroo line of reefs.
Higinbotham ...	178	12 0 0	South of and adjoining the Leviathan.						
Independent ...	173	12 0 0	South-West of the Higinbotham.						
Bulletin	197	12 0 0	South-West of and adjoining the Independent.						
Light of Asia ...	253	12 0 0	2 miles N.E. from Cue.	N.E.	11 feet	Abt. 50° N.W.	Gneissic granite...	Main shaft 112ft. deep, water level. Four prospecting shafts.	Quartz of greyish-blue colour, showing in pieces free gold. About 100 tons of stone at grass.
Queen of May ...	328	9 0 0	N.E. of and partly adjoining the Light of Asia.	N.E.	About 2 feet ...	45° N.W. ...	Gneissic granite...	Main shaft 60ft. deep. Drive 90ft. along reef.	The first crushing of 53 tons of stone gave 1oz. 16dwts. of gold per ton.
Normanby ...	367	6 0 0	About ¼ mile N.E. from the Light of Asia.	N.E.	About 2 feet ...	Flat, West ...	Gneissic granite...	Main shaft 54ft. deep.	The first crushing of 45 tons of stone gave 2oz. 10dwts. of gold per ton.
North Cue ...	231	6 0 0	N.E. of, and adjoining the Normanby.	N.E.	About 2 feet ...	Flat, West ...	Gneissic granite...	Several prospecting shafts.	The first crushing of 30 tons of stone gave 2oz. of gold per ton.
Fleur de May ...	...	12 0 0	4 miles N.E. from Cue.	About E.W.	3 feet	Steep, North	Altered schists ...	Prospecting shaft 70ft. deep. At the 35ft. level two drives along the lode; the Eastern 20ft., the Western 28ft. long.	This is one of the later discovered reefs in the vicinity of Cue; apparently a double lode, a seam of solid quartz along hanging wall. The remaining portion of the lode is filled with a ferruginous porous quartz. The latter contains pseudomorphs after pyrites; crushed and washed it gives very rich prospects of coarse and fine gold. Over 100 tons of apparently rich stone were at grass.

Name of Mine.	No. of Lease.	Area a. r. p.	Situation.	Course	Width of Reef or Lode.	Underlay.	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Day Dawn ...	69	12 0 0	West of Day Dawn town	25° West of North	About 15ft. ...	50° West ...	Dioritic schist	Pumping shaft (vertical) reaches the lode at a depth of 150ft. A cross-cut at that level shows the lode to be 18ft. wide. The water supply is about 1,000 gallons per hour. Three shafts sunk on underlay to the 100ft. level. A drive along the lode at the 100ft. level is about 300ft. long. From the surface to a depth of 36ft. the lode is worked in an open cut.	At the North boundary of the lease, the lode, after bending more Northwards, splits in two and runs into the Union Jack lease. The two branches are from 4ft. to 6ft. wide. This mine has a 20-head stamp-battery, stone-breaker, automatic feeders, etc. About 4,000 tons of stone have been crushed, and gave, on an average, 16dwts. of gold per ton. The open cut appeared, at the time of my visit, dangerous to life. A large tank, about 300yds. distant from the battery, was under construction.
Trenton	326	24 0 0	About 2 miles South-West from Day Dawn town	About 20° West of North	About 3ft. ...	50° West ...	Coarse granular massive diorite.	Main shaft (vertical) 115ft. deep. A drive 84ft. long from the main shaft towards the lode cuts the latter; it is driven on the 105ft. level (water level 55ft.).	This mine has a pumping and winding plant, and a 10-head stamp-battery. The first 50 tons of stone were crushed at the Day Dawn battery and gave 5oz. of gold per ton. About 800 to 1,000 tons of auriferous stone were at grass, and crushing was just commenced when I visited the mine.
Emperor	191	12 0 0	About 1½ mile S.S.W. from Day Dawn town	East, West	About 2ft. 6in. ...	About 65° South	Dioritic schist	Main shaft 50ft. deep. Drive at the 45ft. level 70ft. long. Several prospecting shafts (water level 45ft.); water influx about 100 gallons per hour (water, salt).	This mine has a horse gear, 2 stampers for crushing, and a grinding and amalgamating pan. About 1,500oz. of gold is said to have been obtained during the 2½ years this mine has been worked. About 300 tons of auriferous quartz were at grass when I visited the mine.
Cue Victory ...	167 } 361 }	24 0 0	About ½ mile South of Day Dawn town.	N.S.	2ft. 6in.	54° West ...	Dioritic schist ...	Main shaft (vertical) 75ft. deep (water level 40ft.). Four shafts on underlay to water level (60ft.); 130ft. drives along the reef.	About 200 tons of auriferous stone were at grass, and 50 tons under treatment at the Day Dawn South battery. 500 to 600 ozs. of gold are said to have been obtained by hand dollying.
New Caledonia (Mullocky leader)	218 } 348 }	12 0 0	N.E. from the Cue Victory	N.E.	...	N.W.	Dioritic schist ...	...	About 700 ozs. of gold were obtained by hand dollying from the ferruginous lode matrix of this mine.
Kinsella	207	12 0 0	About 1¼ mile S.E. from Day Dawn town	N.N.E.	6ft.	Vertical ...	Dioritic schist ...	Eight shafts to water level. Water level at 43ft. Water potable	400 to 500 tons of promising auriferous stone were at grass.
Nil Desperandum	251	5 0 0	N.N.E. of and adjoining the Kinsella	N.N.E.	6ft.	Vertical ...	Dioritic schist ...	...	The three leases are situated on the Northerly *continuation of the Kinsella reef.*
Kinsella No. II....	382	4 0 0	N.N.E. of, and adjoining the Nil Desperandum	N.N.E.	6ft.	Vertical ...	Dioritic schist ...	...	
The Hidden Treasure	360	12 0 0	N.N.E. of, and adjoining the Kinsella No. II.	N.N.E.	6ft.	Vertical ...	Dioritic schist ...	...	

2.—CUDDINGWARRA.

This mining locality is situated about 10 miles to the west of Cue.

A number of auriferous reefs and lodes traverse the altered schist country formation, and amongst them the prevalence of a N.N.E. course is noticeable.

A few slight but rugged elevations are formed by the outcropping banks of ferruginous and silicious altered schists.

Gold shoots in the lodes seem to have no great horizontal extent, and they also apparently occur here chiefly along lines of intersection between main lodes or reefs and transverse fissures.

The water level lies here at an average depth of about 40 feet below the surface, and the water is salt.

The progress in the development of the mines has proceeded favourably.

3.—LAKE AUSTIN—ISLAND AND MAINLAND.

Within the Lake Austin depression, and about fourteen miles to the South of Cue, is situated a mining locality called "The Island," and about three miles, in a North-Easterly direction from the latter, across the lake lies "the mainland."

A rugged range, consisting of altered schists and chiefly of banks of banded ferruginous jasper and banded silicious ironstone, forms an insular elevation within the lacustrine depression. The length of that range is about $2\frac{1}{2}$ miles, its average height about 100 feet above the lake, and its longitudinal extent a few degrees East of North.

The Northern continuation of the break, to which that range owes its existence, disappears for about two miles below the level of the lacustrine depression, but a few insular rock outcrops show a connection with the hills of the mainland.

Those hills, partly forming the Northern shore of Lake Austin, rise to an average height of about 80 feet above the level of the lake.

The above-mentioned break extends in an arch shape for several miles, and the two mining localities form conspicuous portions along its course.

The geological formation, and also the nature of the gold deposits, is very similar in both these localities.

The main break is followed by a number of diorite dykes and auriferous reefs and lodes.

A more or less common character of those reefs is that they contain very rich shoots of gold ore, and that the occurrence of those rich shoots is more or less confined to intersections of the main reefs with dykes, cross reefs or cross fissures.

The water, in consequence of the situation, is very salt, and the water level in most of the workings was reached at a shallow depth.

Although a large quantity of gold has been produced, the working of the mines was confined to rich shoots above the water level, and at the time of my visit hardly any preparations for a continuation of the workings in a downward direction were visible.

CUDDINGWARRA.

Name of Mine.	No. of Lease.	Area	Situation.	Course	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Fortune of War	95	a. r. p. 12 0 0	At Cuddingwarra ...	N.E.	3ft.	Vertical	Dioritic schist.	Main shaft (10ft. x 4ft.) 85ft. deep. (Water level 50ft. Water, salt.) Pumping shaft (outside lode) 110ft. deep. For a length of 70ft. and down to a depth of 40ft. the lode is stooped.	This mine has a pumping plant and a 10 head stamp battery. About 400 tons of auriferous stone were at grass, and crushing was started.
Victory United ...	204	9 0 0	N.E. of and adjoining the Fortune of War.	N.N.E.	3ft.	Steep East	Dioritic schist.	Main shaft 88ft. deep. Underlay shaft (South of main shaft), 101ft. Drive at 52ft. level about 50ft. long. Three stoops.	Winding plant and 10 head stamp battery were at the time of my visit in course of erection, and about 200 tons of auriferous stone were at grass.
Blue Bell	316	5 0 0	About 1¼ mile North of Fortune of War. ...	N.N.E.	1ft. 6in.	About 42° E.S.E.	Dioritic schist.	Two shafts on underlay 26ft. Drive along lode at the 25ft. level, 60ft. long. (Water level 26ft.)	About 100 tons of auriferous stone were at grass, and part of it was rich.

LAKE AUSTIN (ISLAND).

Name of Mine.	No. of Lease.	Area	Situation.	Course	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Shamrock & Chicago	86	A. R. P. 5 3 6	Island in the Lake Austin depression.	N., S.	2ft. to 5ft.	Flat West ...	Dioritic schists ...	Deepest shaft, 60ft. Rich gold shoots have been followed in an irregular manner.	Several thousand ounces gold have been obtained by hand dollying from those claims.
Eureka	145	5 2 25	About ¼ mile N.E. from Shamrock and Chicago.	N., S.	2ft. 6in.	About 60° W.	Dioritic schists ...	Main shaft, 85ft. deep; South shaft, 60ft. deep. Short drives and stopes.	About 200oz. of gold is said to have been obtained by hand dollying. The first 25 tons of stone crushed gave 2oz. of gold per ton. About 80 tons of auriferous quartz were at grass.
Golconda	144 151	18 0 0	N.E. of and adjoining the Eureka.	N., S.	About 4ft. ...	Slightly West	Dioritic schists ...	Main shaft 70ft. deep (water level). Three shafts besides. One drive along lode at water level 80ft. long. Drives at higher levels about 170ft. long.	In this mine several rich shoots have been worked, and the gold obtained by hand dollying is estimated by outsiders at about 2,000oz.
Evening Star ...	98	6 0 0	N.E. of and adjoining the Golconda.	N.E.	2ft. 6in.	Flat North-West, turning steep at 45ft. level.	Dioritic schists ..	Main shaft 45ft. deep (vertical), close to water level; four shafts besides.	During the last two years about 1,500oz. of gold were obtained by hand dollying. About 300 tons of auriferous stone were at grass. The owners had in their hut about four cwts. of picked stone containing about 400oz. of gold.
Ironclad	559	6 0 0	S.S.W. of the Shamrock and Chicago	15° East of North.	2ft. to 5ft.	Slightly West	Dioritic schists ...	Main shaft 44ft. deep; two shafts besides. Drive at water level, 200ft. long. Two open cuts.	About 200 tons of auriferous stone were at grass

LAKE AUSTIN (MAINLAND).

	Name of Mine.	No. of Lease.	Area	Situation.	Course	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
The Mainland Consolidated.	Last Chance	130	A. R. P. 6 0 0	On the Mainland (N. shore of Lake Austin.	10° East of North.	1ft. to 18in.	Very flat West.	Diorite interchanging with schists.	Main shaft 66ft. deep (vertical). Drives in four levels and along the lode. Total length of drives, each 600ft.	*The reef contains quartz and a schistose matrix, which occasionally becomes so ferruginous that it can be considered as ironstone.* Over 3,000oz. of gold have been obtained from three small but very rich shoots.
	Mainland ...	113	9 0 0	About ½-mile W.S.W. from the Last Chance.	N.E.	2ft. 6in.	Slightly N.W.	Diorite interchanging with schists.	Main shaft 60ft. deep (water level) 150ft. drives along bottom level. *Extensive stopes.*	About 100 tons of auriferous stone at *grass, and very rich stone stored.*
	Daly's Reef ...	114	9 0 0	E.N.E. of and adjoining the Mainland.	Two reefs, the continuation of the Mainland reef and a cross reef; the latter:—N.W.		Flat towards N.E.	Diorite interchanging with schists.	Main shaft 60ft. deep (water level). About 200ft. of drives along the bottom level.	Two very rich gold shoots have been followed down to the water level.

The three mines have one 3-head stamp battery, driven by a small locomotive. About 7,000oz. of gold were obtained from the three mines during the last two years.

4.—NANNINE.

The geological features of this place are a repetition of many others within the interior gold region.

We here again find a break in the archæan earth crust: the subsidence of the portions West of that break, the formation of reefs, dykes, fissures, and faults, and also the usual alteration of the country rock along their course.

A main reef, on which the mines are operating, has a Northerly course, underlaying slightly towards the West.

The country formation is dioritic schist, which, near the surface and along the lode, is altered into talcose and chloritic schists. Banks of ferruginous jasper, or schistose silicious ironstone, are running transverse to the reef, and on the lines of intersection rich shoots of gold ore have been found to occur.

Most probably the same hydrothermal action which has introduced the gold into the fractured portions of the reef, has also effected the alteration of the country rock along the continuation of those transverse fractures, by introduction of silica, partly removal of bases, and a complete recrystallisation of the rock material. The schistose structure was retained, or even more highly developed, under the continuation of tangential pressure.

A few hundred yards to the West of the lode rotted granite rises to the surface.

Shafts and workings have extended considerably below the water level, and the difficulties connected with that circumstance could be most effectively overcome by a united action of the mines.

The future of the mining industry in this place depends greatly on the arrangements under which the operations will be continued, and also what means will be employed to enable the managements to follow the known rich shoots below water level, and to search for and to open up new ones.

The manager of the Nannine mine has already faced that task in an energetic manner, and as his efforts are based on a thorough knowledge of his ore deposit, and properly adapted to circumstances, they will doubtlessly lead to success.

5.—STAR OF THE EAST.

The Star of the East mine is situated near Yagahong hill, about 20 miles to the East of Nannine.

The main lode on which mining operations are conducted has dioritic schists as country formation, and the junction of the latter with partly decomposed gneissic granite lies to the West not far distant from the lode.

The lode fissure has probably once served as a vent for thermal waters, and the so-called opaline beds in its vicinity are very likely remnants of hydrothermal deposits.

6.—GARDEN-GULLY.

This place is situated about 41 miles from Nannine in a Northerly direction.

The country here is level, and covered mostly by secondary formations, such as a layer of earth derived from accumulative decomposition, old lacustrine alluvium, and fluviatile alluvium of more recent date.

The reefs occur in dioritic schists. The water level lies about 40 to 50 feet below surface, and the water, although hard, is potable.

7.—ABBOTT'S FIND.

This place is situated about 50 miles in a West of Northerly direction from Nannine, and at the head of a large but usually dry creek.

Its main feature is a line of auriferous quartz reefs extending in a Northerly direction for over a mile.

The country formation is dioritic schist, which in the vicinity of the lodes or reefs is highly altered.

The water-level lies at a depth of about 170 feet from the surface, and the water, although hard, is potable.

Several rich gold shoots have been followed down with shafts, and trial crushings gave very promising results.

The occurrence of rich gold shoots seems here also connected with cross fissures extending through main reef and country formation.

8.—WEST MOUNT MAGNET.

The principal mines are situated Southwards of West Mount Magnet, and respectively $2\frac{1}{2}$ and one mile distant from the mountain top.

Here also, as well as in most of the auriferous localities within the interior gold region, a belt of paleozoic greenstones has broken through the archæan strata.

The latter contain the ore deposits on which the development of the mines is progressing.

NANNINE.

Name of Mine.	No. of Lease.	Area a. r. p.	Situation.	Course	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Nannine	1	12 0 0	¼ mile East of Nannine Town	N., S.	3ft.	Slightly West	Dioritic schists ...	Main shaft, 155ft. deep. The principal shoot in the main reef has been followed to a depth of 95ft.; that is, 45ft. below water-level. It is the intention of the manager to continue the main shaft to a depth of 250ft., and to drive a crosscut for the main gold shoot.	This mine has a 10-head stamp battery. 2,200 tons of stone crushed gave 2,263 ozs. of gold. The value of the gold is about £3 15s. per oz. Over 600 tons of quartz have been crushed by this battery for other mines.
Royalist	2	2 2 20	South of and adjoining the Nannine Mine	N., S.	3ft.	Slightly West	Dioritic schists ...	Main shaft, 80ft. deep. Drive along reef. Two gold shoots have been followed by the workings.	In this mine the Nannine Reef is crossed by a wide diorite dyke; the latter has a Westerly course. 120 tons of stone crushed gave 700 ozs. of gold.
Murchison Consolidated. Victory (Conolly Murchison)	3 & 4	21 0 0	South of and adjoining the Royalist	N., S.	...	Slightly West	Dioritic schists ...	The workings consist chiefly in the following up of shoots above the water-level, and in drives executed with the object of finding new shoots. The water-level was reached at an average depth of 70ft.	This mine has a 10-head stamper battery. Since January, 1893, up to the 31st of July, 1894, 4,500 tons of stone were crushed, and 4,300 ozs. of gold obtained. The average price of the gold at the mint was £3 15s. per oz. The alloy was silver, for which payment was made.
Murchison Consolidated. Queen of the Lake	20	11 3 0	About 2 miles North from Nannine Town	N., S.	3ft.	Slightly West	Dioritic schists.		
Murchison Consolidated. Caledonian ...	21	6 0 0	North-East and in the vicinity of Nannine Town	...	...	...	Dioritic schists.		

STAR OF THE EAST—GARDEN GULLY.

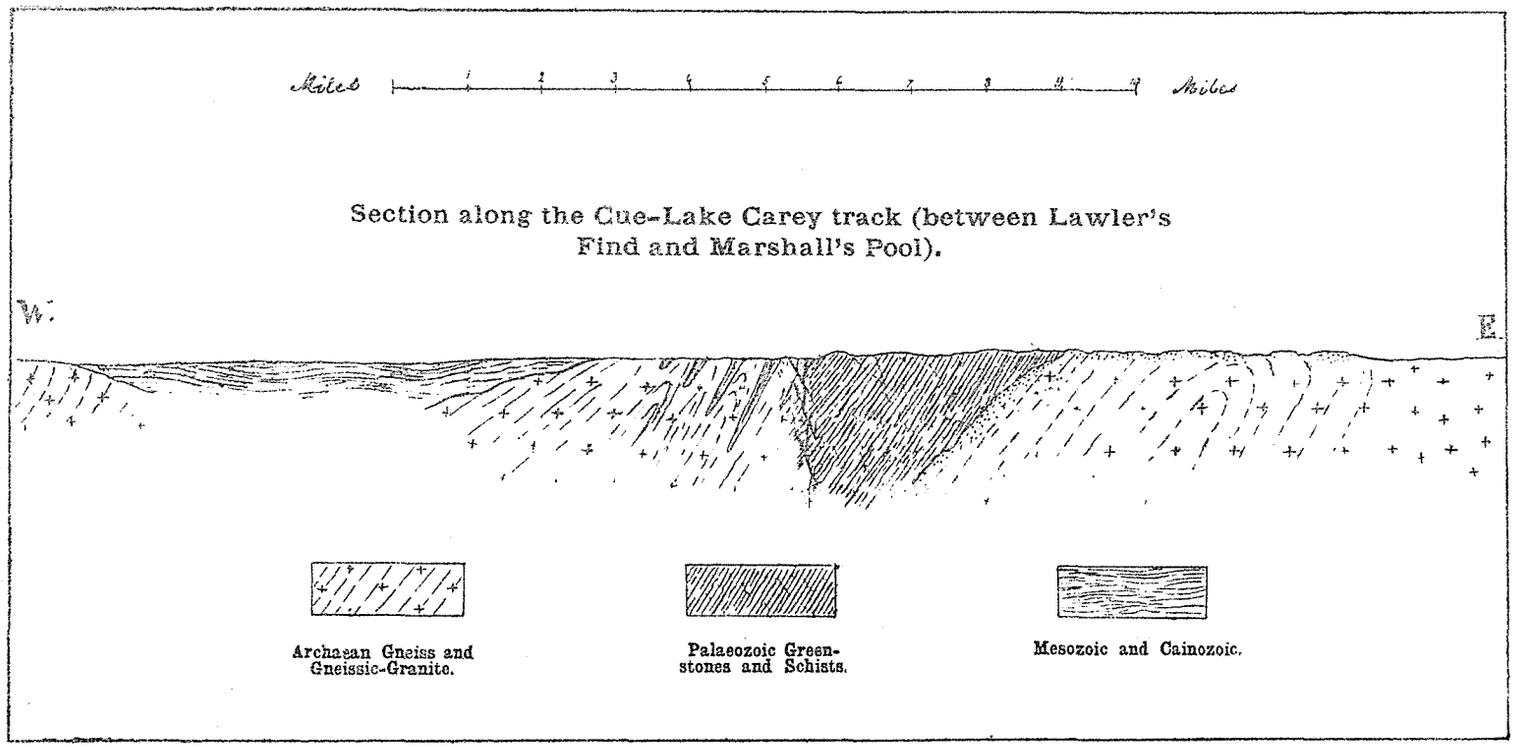
Star of the East...	344	25 0 0	20 miles East of Nannine	More or less E. and W.	8ft. to 14ft. ...	70° South ...	Dioritic schists ...	Main shaft 82ft. deep. (Water in it potable.) Drive on the 50ft. level Eastwards along the lode 138ft. long connecting air shaft. Drive on the same level from the main shaft Westwards 86ft. long.	A rich ferruginous band of quartz which averages about 2ft. in thickness runs along in the lode matrix. The latter consists largely of broken country formation with ferruginous quartz and silicious ironstone re-cementing it. The whole mass has proved auriferous. At the time of my visit a 10-head stamp battery was at work, and 10 additional stampers in course of erection. Since November, 1893, about 2,680 tons of stone have been crushed and 7,036ozs. of gold obtained. The gold has realised £3 6s. per oz. at the mint. The alloy was silver.
Garden Gully ...	427	19 0 0	41 miles in an East of Northerly direction from Nannine	More or less N.N.E.	About 8ft. ...	Slightly N.N.W.	Diorite and dioritic schist	Two shafts to water level 50ft. deep. A drive along the reef on the 50ft. level 110ft. long.	About 700 tons of auriferous stone were at grass. When I visited the mine the erection of a 10-head stamp battery was nearly completed.
Isak and Allower's prospecting area	...	...	About 1½ miles East of the Garden Gully mine	More or less N.N.E.	About 2ft. ...	Slightly N.N.W.	Diorite and dioritic schist	Main shaft 30ft. deep.	A trial shaft 12ft. deep shows a defined quartz reef. The quartz is of a dark greyish colour, and shows occasionally small specks of gold.

ABBOTT'S FIND.

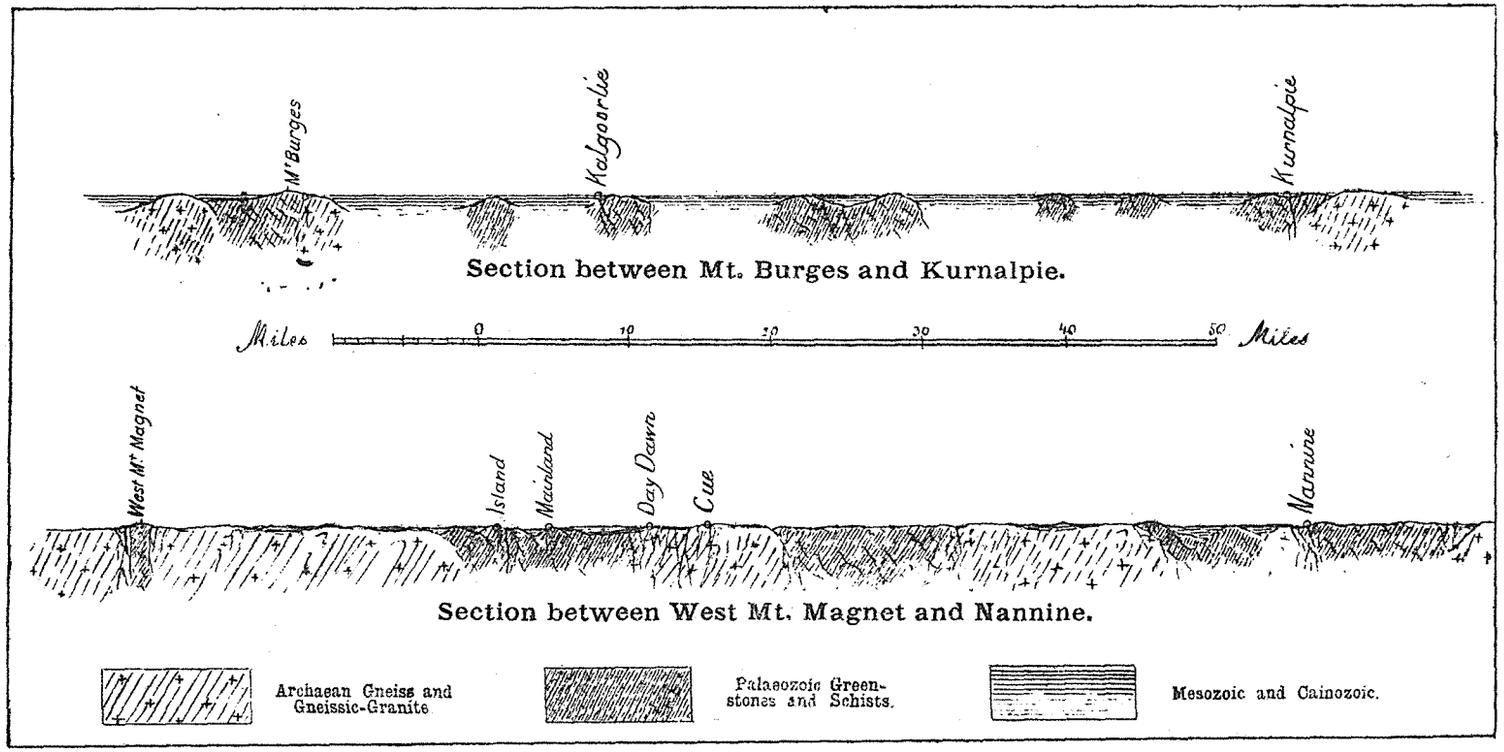
Name of Mine.	No. of Lease.	Area a. r. p.	Situation.	Course of Reef or Lode.	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
Ophir	152	12 0 0	About ½ mile South of the main camp	Almost N.S. (three parallel lode outcrops)	(?)	East	Dioritic schists ...	Prospecting shaft 60ft. deep	Some of the quartz raised showing coarse and fine gold. The quartz contains hematite pseudomorph after pyrites.
Black Iguana ...	128	8 0 0	North of, and adjoining the Ophir	N.S.	2ft. 6in.	About 70° East	Dioritic schists ...	Main shaft 180ft. deep. For 75ft. sinking in this shaft a Government bonus of £2 per foot was obtained in the year 1893. Water level at 170ft. The water is hard but potable. A shaft sunk on an Eastern lode-branch 45ft. deep.	The quartz is similar to that in the Ophir. Ten tons of stone crushed at the Nannine mine gave 2ozs. 12dwts. of gold per ton.
Mount Wranizon South	127	8 0 0	North of, and adjoining the Black Iguana	Main lode N.S., cross-lode E.W.	Main lode about 2ft.	Main lode 70° East	A magnesia aluminium silicate, probably a result of alteration of dioritic rocks under hydro-thermal action	Two prospecting shafts 12ft. and 30ft. deep ...	About 30ozs. of gold have been obtained by hand dollying. The quartz is of a greyish colour.
Mount Wranizon	129	12 0 0	North of, and adjoining the Mount Wranizon South	N.S.	2ft.	About 70° East	Decomposed dioritic schist	A main shaft started about 120ft. East of the lode outcrop had reached a depth of 143ft. An underlay shaft 60ft.	About 10 tons of stone from this mine have been crushed at the Nannine mine and gave 9ozs. 10dwts. of gold per ton.

WEST MOUNT MAGNET.

Name of Mine.	No. of Lease.	Area a. r. p.	Situation.	Course of Reef or Lode.	Width of Reef or Lode.	Underlay	Country Rock.	Extent of Workings at the end of August, 1894.	Remarks.
New Chum ...	92 171	15 0 0	About ½ mile W.S.W. from Warramboo Townsite	Almost N. and S.	2ft. to 5ft. ...	72° West ...	Talcose schist ..	Main shaft 166ft. deep. Underlay shaft 180ft. There are drives on the 80ft. and on the 150ft. levels. The total length of drives is 180ft.	This mine had an Otis crushing mill for a considerable time working. From 953 tons of crushed stone 2,935ozs. of gold were obtained. At the time of my visit a 10-head stamp battery was in course of erection.
New Chum, South	404	12 0 0	South of and adjoining the New Chum	N.E.	2ft.	70° West ...	Talcose schist ...	Main shaft 65ft. deep. A drive in a Northerly direction along the lode about 30ft. long.	About 50 tons of auriferous stone at grass.
Morning Star ...	568	12 0 0	About 1½ mile N.W. from Warramboo Townsite	More or less E. and W.	3ft. to 6ft. ...	75° South ...	Talcose schist ...	Main shaft 100ft. deep. Underlay shaft 110ft. Water level—Water, salt.	About 200 tons of very promising auriferous stone were at grass. A complete winding, pumping, and crushing plant (10-head stamp battery) was, at the time of my visit, on the way to the mine.
Easter	155	6 0 0	South of and adjoining the Morning Star	More or less N. and S.	About 3ft. ...	About 75° West	Talcose schist ...	Main shaft 108ft. deep. The workings are following a rich shoot. The latter has a Southerly dip.	A small 3-head stamp battery, driven by hand, is at the mine. About 3,000ozs. of gold have been obtained since April, 1893. About 100 tons of auriferous stone at grass.



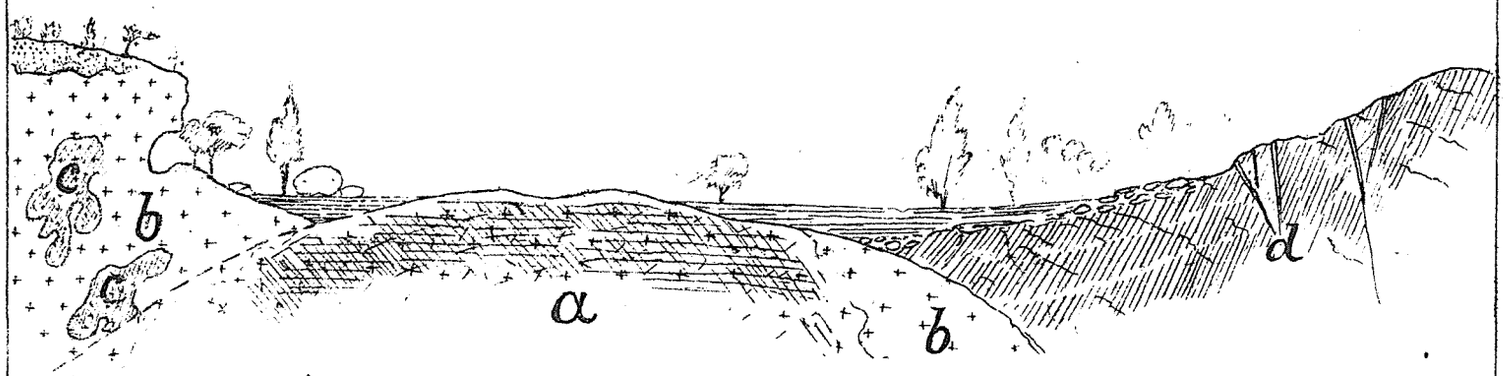
Section along the Cue-Lake Carey track (between Lawler's Find and Marshall's Pool).



Section between Mt. Burges and Kurnalpie.

Section between West Mt. Magnet and Nannine.

Contact Zone between Archaean granitic and palæozoic dioritic formations (about 12 miles South of Nannine).



a Massive Granite. *b* Decomposed Granite. *c* Granophyre enclosures. *d* Dioritic Schists and Diorite.

The country formation around the auriferous reefs and lodes consists chiefly of talcose schists, and shows a West of Northerly strike with a Westerly underlay.

The talcose schists here were originally mica schists, which became altered by decomposition and the removal of bases of their component minerals.

The material of the removed bases is found in dolomitic beds, which are often met with in the surroundings. Those beds are most probably old lacustrine precipitates.

This far reaching alteration is apparently due, in the first instance, to a contact with the eruptive material of the paleozoic greenstones, and afterwards to hydrothermal action, to which latter the auriferous deposits most likely owe also their origin.

Some of the lodes contain besides seams of auriferous quartz considerably large talcose formations. This is similar to some of the occurrences at Cue. A similar action has produced those features, but whereas at Cue it acted on gneissic granite, at Mount Magnet it acted on mica schist. Consequently in the former place the kaolinous, and here the talcose material is predominant in those lode formations.

VII.—DESCRIPTION OF COUNTRY BETWEEN WEST MOUNT MAGNET AND SOUTHERN CROSS.

Proceeding from West Mount Magnet in a Southerly direction for a few miles, we enter the archæan main portion of the great West Australian table-land.

Its chief petrographic features are, as already described in one of my previous reports, gneiss and gneissic granite. This formation continues without interruption till we arrive in the vicinity of the Canning Hills.

Those hills consist of paleozoic greenstones (chiefly dioritic schists) and are like the West Mount Magnet country, a Western branch of a petrographically similar main formation, which is situated several miles further Eastwards. This main formation includes East Mount Magnet, Wyemandoo, and the surroundings of Mount Kenneth.

The average height of the archæan portion of the plateau is here about 1,400ft., and the height of the adjoining flat lacustral country, situated to the East, is about 1,100ft. above the sea level.

Out of this flat country rugged greenstone hills and ranges rise here and there to a moderate height.

Lake Moore extends over a break in the archæan strata, along which a few subsidences, and also several slight horizontal dislocations have occurred. In the South-Eastern portion of the Lake Moore depression we meet with a few greenstone dykes of moderate size.

As we proceed further to the South, we re-enter, near Mount Churchman, unbroken archæan country, the Easterly extent of which reaches a few miles beyond Mr. Giles' Pigeon rocks.

Along the route from Lake Austin to Mount Churchman we find old lacustral strands (cliffs), some of which are occasionally situated about 200ft. above the general level of the Easterly lacustrine depressions.

The Lake Moore and Lake Barlee depressions have their junction in the Warne Flats, and at one time the waters of those two lakes have also joined in those flats.

The Eastern border of the archæan main portion of the great West Australian table-land extends from the Pigeon rocks Southwards to Carracubbing, from which latter place, 22 miles in an E.N. Easterly direction, the mining locality known under the name of Mount Jackson is situated.

Mount Jackson itself lies about 10 miles further Eastwards, and forms a prominent point in a rugged greenstone range, consisting chiefly of dioritic schists.

A similar country formation continues in a Southerly direction from this place to Knutsford (Golden Valley), Southern Cross, and beyond that place to Parker's Range.

The junction between this formation and the archæan main portion of the great West Australian plateau is more or less accompanied by saline lacustral depressions, of which Lake Deborah is the most prominent.

VIII.—MINES IN THE MOUNT JACKSON COUNTRY.

The *Nil Desperandum Gold Mine* is situated about 10 miles West of Mount Jackson, and about 22 miles E.N.E. of Carracubbing.

It comprises a 15-acre Gold Mining Lease and a reward claim, measuring 500 feet by 400 feet.

The country formation is dioritic schist considerably decomposed towards the surface.

The ore deposits consist of several massive quartz reefs which tend more or less towards a small rise in the otherwise flat surroundings. This rise occupies the central portion of the mining property.

At the time of my visit to the locality (October, 1894), a well timbered underlay shaft was sunk to a depth of 46 feet. It was sunk on a main reef of Northerly course and Westerly underlay of about 60 degrees.

The average width of the reef in the shaft appeared to be from four to five feet.

A reef of smaller size, crossing the above, intersects it in the immediate vicinity of this underlay shaft.

A little further North from this shaft a vertical shaft is sunk on another reef, and reached, at the above-named time, a depth of 72 feet.

The width of this second reef will also average between four and five feet.

Besides these, several shallow prospecting shafts and costeen pits were sunk.

The quartz is more or less ferruginous, showing frequently coarse and fine gold, and is generally of a promising character. At the time of my visit about 150 tons of such stone were at grass.

With the intention of preserving surface water, the mine owners were excavating a large tank at a distance of about one mile from the mine.

The water level in this locality is not likely to lie at a great depth, and the underground water, in all probability, will be salt.

The Victoria Gold Mine is situated about one mile to the north of the Nil Desperandum, and the gold mining lease comprises 15 acres, in one section.

The mining operations within the same are concentrated upon a reef of northerly course, with a steep easterly underlay, and an average width of about four feet.

The country rock is the same weathered dioritic schist as at the Nil Desperandum.

Besides three prospecting shafts, at the above-named time a main shaft was sunk to a depth of 70 feet.

The auriferous stone which had been raised was ferruginous, and of promising nature. About 50 tons of it were at grass.

IX.—MINES AT GOLDEN VALLEY.

The country formation here consists of similar dioritic schists, as in most of the auriferous portions of the interior gold region.

At the time of my visit (October, 1894) only two mines, both being under the same management, were at work.

The quartz, in both the Kathleen and the Waterhall mines is ferruginous in the higher, and contains pyrites in the lower levels. Specks of free gold, associated with auriferous pyrites, could frequently be seen in the stone raised in the Kathleen mine at the 80ft. level.

According to information received from the manager, the stone that was treated from both mines gave an average return of over 1oz. of gold per ton.

The Kathleen Gold Mine is situated about a quarter of a mile North of the townsite of Knutsford. It comprises a gold-mining lease of 25 acres, and the auriferous ore deposit consists of a wide quartz reef which, on approach towards the surface, splits into two or, perhaps, more branches. The course of this reef is a Northerly one. In the stopes, at a depth of about 80ft. below the surface, the reef presents a width of from 6ft. to 8ft.

This was, at the above-named time, the greatest depth attained.

A main shaft was being sunk, and had reached a depth of 45ft.

This is one of the oldest mines in the Yilgarn Goldfield, and possesses a hoisting plant, a 10-head stamper battery, and a rock-drill, worked by compressed air.

The Waterhall Gold Mine is situated to the South of and adjoining the Kathleen.

The lease comprises only three acres, through which runs the Southern continuation of the Kathleen reef.

Two branches of the reef, separated by an intervening portion of country formation, have been worked in an irregular manner to a depth of about 60ft.

X.—THE DEVELOPMENT OF THE GOLD-MINING INDUSTRY IN THE INTERIOR AURIFEROUS REGION.

Since I wrote my first official report on the Central Goldfields of Western Australia (December, 1893), the circumstances within the interior auriferous region have greatly altered.

A comparatively enormous influx of population has taken place; a large additional number of valuable new gold deposits have been discovered; the railway to Southern Cross has been completed; telegraphic communication has been established with several centres of the Coolgardie and Murchison Goldfields; roads and tracks have been extended in all directions; towns are growing rapidly in places, where two years ago hardly a few tents stood; teams loaded with necessaries of life, and mining implements; long caravans of camels, attended by bronze-faced Afghans, and dark-coloured men from India; and great numbers of travellers on various conveyances and on foot, are now often met with on the roads leading towards the various mining centres.

In places where at the above-mentioned time it was counted an event to come across a party of sturdy prospectors, or even across the tracks of their hardy Western Australian bred horses, now one might meet at any time vehicles, horses, or camels conveying men, who six weeks before perhaps have trodden the pavement of Regent Street, in London; or even women, children, and ministers of various denominations.

Great and partly successful exertions have been made by the Water Supply Department of the West Australian Government along the roads, and by private enterprise at the mining centres, to procure and to preserve the water necessary for the large number of people and animals moving now within the auriferous region.

The West Australian gold deposits have cast their spell, and the attraction they exert is no more confined to the venturesome prospector and digger, and a few adventurous speculators; but it affects already men of various classes and callings, not only from within, but also from far beyond the sea border of this Island-Continent.

The gold-mining industry here has entered into the second stage of development.

During the first stage the venturesome prospector and digger were the principal elements in the goldfields. Energetic men, with experience that fitted them well for the task they undertook, came from the Eastern colonies as soon as the news of the first gold discoveries on the Murchison goldfield became known; some of those men had followed up digging all over the goldfields of Australia, and amongst them several have seen the early digging days in Victoria.

The great strike in the silver mines of Broken Hill has deprived a large number of energetic men of their occupation; they had to search for new fields of action, and the goldfields of Western Australia have offered to them at that time charming prospects. Many active men, well acquainted with, and trained for actual mining work, have arrived from that place.

A little later all the Eastern colonies, and all classes of society, have contributed their share of men.

The nature of the secondary auriferous deposits gave here no advantage to the experienced digger; therefore his, we may say chivalrous and romantic views have not attained generality as they did in some of the early Australian goldfields. It was a more sober and matter-of-fact consideration of the circumstances which generally pervaded the minds of the pioneers of the interior gold region, greatly to the regret of those who expected to draw advantage from human generosity and weakness.

Still, the old digger had his large share in the opening work, and to him, and his high notions of justice and order, as well as to the creditable reminiscences connected with his calling, it was due, that in the most desolate wilderness, as well as amongst the large crowds of men, consisting of members of all classes and possessed of the most diverging notions, the well-disposed individual could pursue his exciting occupation, according to law, and as safely as within a well regulated community, although the State authority on the goldfields was insignificant, and, in consequence of natural obstacles, often unapproachable.

There is still left a large field for the digger and prospector within the auriferous region; but the atmosphere of the new gold-mining centres, after the influx of other human elements, becomes uncongenial for that stamp of men, and their restless energy and perseverance in the combat with natural difficulties leads them further and further, discovering and opening continuously new resources for the following crowds and the community at large.

With the introduction of the acquirements of civilisation, the second stage in the growth of the gold-mining industry in this region was entered upon; and the continuation of the work has been, and is continually taken up by greater numbers with and without capital, with and without knowledge and experience.

The uncertainty during this period, and the chances of great monetary rewards for small pecuniary or other exertions, are producing a great attraction; and a state of excitement has commenced, which draws continually larger and larger numbers into its circles.

In the history of mining, and also Australian mining, great follies and acts of rascality have been committed during similar periods, which have caused to a large number of people the name of mining enterprise and swindle to appear almost synonymous; so that most of those who enter at the present time into West Australian mining concerns base their calculation of expected profits by far less on the actual state and merit of the gold deposits than on the excitement which the richness of the latter is bound to cause.

The interior auriferous region of Western Australia is of such large extent, and the rich gold deposits already discovered within it are so numerous—and still daily increasing—that the further prosperous development of the gold-mining industry may be considered as ensured, and beyond the dangers to which, in a smaller goldfield, the rapacity of promotors and schemers might expose it.

The enormous extent of the auriferous region, and the large number of gold deposits within, will have the effect that no company or syndicate (however dazzling the prospects of their mining objects may present themselves at one or the other time) will be able to monopolise the attention of the investing public; and many of those who have entered West Australian gold-mining enterprise with the intention of becoming so-called "first robbers," will soon find out that it will pay better to devote more attention and energy to the mines than to the rigging of the scrip market.

The auriferous deposits of the interior gold region possess the natural vitality which is capable of victoriously carrying the gold-mining industry through the worst conditions and circumstances, to a successful and prosperous issue; and the time is not far distant when those deposits will offer a greater choice to the gold-mining investor than has ever been offered before.

To the man who will exert the necessary circumspection, it will be an easy matter to discern *bonâ fide* enterprise from "wild cat" concerns, and circumspection will not involve loss of opportunity.

That the gold-mining industry is bound to assume enormous proportions within the interior auriferous region can be already seen from the present state of development; and judicious joint action or co-operation of the mining community in affairs of common interest, and also that of its component parts, where such only are concerned, could ensure a more rapid progress, with attainments of most gratifying results, at the smallest possible expenditure.

Such a course would benefit, in the first instance, those who are directly involved in mining enterprise, but also in a great measure the community at large.

A few special references will throw more light on this matter:

For instance, to overcome natural, technical, and economical difficulties—with which mining enterprise in this region meets—the best and most reliable devices could be obtained from an institution established and sustained for that special purpose.

Such an institution, scientifically conducted, and provided with the means for the execution of necessary practical experiments, would be capable of devoting its whole attention to the most urgent questions concerning the gold-mining industry, and to their satisfactory solution.

By periodical publication of critical observations, and experimental results, affecting local gold-mining, individual mines and groups of mines would be put into possession of reliable facts and data upon which to base their operations, without incurring heavy expenses by inadequate trials; and the value of instruction, diffused amongst the mining community, would soon find its expression in an increased gold production and a considerable reduction in the aggregate sum of calls.

The means for the establishment and carrying on of such and similar institutions could be raised by rates, say, so much per acre from every gold-mining lease, after the lease has been in force for one year; further, by a tax on declared dividends, and by a Government contribution of an equal amount taken from the goldfields revenue.

The administration of such concern or concerns could be entrusted to a board of delegates, elected by the citizens of the goldfields from amongst themselves, the Government reserving for itself a certain amount of control in the matter.

The establishment of District Mining Boards, endowed with similar powers as representatives of municipalities, could initiate, manage, and control affairs of common interest within mining districts, and greatly aid the progress of the gold-mining industry.

Concerning crushing and gold extraction, most effective results in treatment and in saving expenses could be obtained by the co-operation of districts.

Centrally situated works, connected by tram lines with the various mines, fitted with the best suited machinery, and conducted by able management, could buy the gold ores of the district according to a tariff fixed by the assay-yield of properly taken samples, and by the nature of the ore.

The ideal would be that such works should be owned by the district, and under the arrangement that every mine delivering ore to the works would participate in the profits made by those works in proportion to quantity and quality of ore delivered during the respective periods. In this case successful exertions, instead of benefiting one enterprise alone, would be to the advantage of the whole mining community of the district and the mining industry in general.

District crushing and gold extraction works could do work at a cheaper rate, and be far more effective, than any plant owned by one single mine.

The raised gold ore becoming a marketable produce, mine owners and mine managements would be relieved of a large amount of trouble, and would be enabled to devote a great deal more energy to their mines.

For certain groups of mines it would be advantageous to co-operate so far as to have a common pumping, and, in some instances, hoisting, and hauling station; considerable saving would be effected in capital outlay, as well as in the current cost of production.

To overcome, for example, the fuel difficulty on the Murchison Goldfield, a joint action of its mining community could easily and advantageously ensure the establishment of a power generating plant at Champion Bay (where cheap coal is procurable), and the electric transmission of generated power to the mines, crushing works, and towns of the field.

In most of the reefs or lodes within the interior auriferous region, the gold occurs chiefly in shoots or ore columns. The horizontal extents of such shoots along the course of a reef are seldom defined by nature. The most common occurrence is a gradual decrease in richness from the axis of a shoot in both directions along the reef.

It lies, therefore, in the nature of the gold deposits, that the available quantity of payable gold ore increases at a progressive rate with the reduction of the mining and crushing expenses.

As a judicious co-operation of the producers would be most capable of ensuring reductions in the cost of production, without interfering with the rate of wages, this course will recommend itself.

The almost universally recognised standard value of gold, and the world's large and increasing demand for that metal, exclude all rivalry from amongst producers, and facilitate matters in that line.

The advantages deriving from a general adoption of such a course would be enormous, and would benefit, in the first instance, the producers, but greatly, also, the community at large.

Under such conditions, the gold-mining industry within the interior auriferous region would be capable of assuming gigantic proportions; the initiation of mining enterprises could be effected without having recourse to those enormous over-capitalisations, without which it seems now hardly possible to procure the comparatively small amount of working capital required; a large portion of the goldfields population, now held back by distrust, would be enabled and induced to enter into actual mining enterprise, with capital, physical force, and experience combined; and a very desirable, productive, and settled class of citizens would evolve out of the present roaming population, the individuals of which are either homeless, or do not find sufficient inducement to transfer their homes to the places on which they find it profitable to employ temporarily their personal activity.

Although this is not the place to dwell upon the subject from a point of political economy, it is hardly possible not to observe the enormous influence which the introduction of a proper system, and economy into the gold-mining industry, could exert on the future greatness of this Colony.

No doubt the nature and richness of the gold deposits are sufficiently inducive to ensure the establishment of the gold-mining industry on a large scale. Outside capital will make use of the chances which are offered for its profitable employment; but, for the risk which this capital takes, it demands exceedingly high remunerations within an absolutely unreasonable space of time.

In the endeavour to satisfy those usurious demands, all the energy available for the conduct of mining enterprises becomes absorbed in efforts towards the attainment of momentary results. Under such circumstances, no provision can be made for preparatory work, as commended by experience.

Work preparing, and setting in view the production for years ahead, and imparting to mines and mining enterprise in general the necessary security, cannot be thought of; and an industry which actually produces and supplies a requirement of our civilisation, and on which in the meantime the livelihood of thousands of persons becomes dependent, is left entirely to the mercy of accident.

The enormous extent of the interior auriferous region, the large number of gold deposits within it, the nature of the latter, and also the circumstances connected with it, will here most likely force gold-mining enterprises to a solid and business-like basis.

The gold-mining industry is bound to exert a predominant influence on the destiny of this Colony; and strikes, as experienced lately in the Eastern colonies, would be far more disastrous here.

One of the precautionary measures against the occurrence of such an eventuality would be the reservation and exertion of a controlling influence by the Crown—a controlling influence which would enable the latter to encourage systematical mining, and to enforce the preservation of the gold resources of the Colony from ill-usage and destruction.

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