

1890.

WESTERN AUSTRALIA.

ANNUAL GENERAL REPORT

FOR

1888—1889,

BY

HARRY PAGE WOODWARD,

F.G.S., F.R.G.S.,

GOVERNMENT GEOLOGIST.

PERTH:

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The Honorable the Acting Colonial Secretary.

SIR,—

I have the honor, herewith, to hand you, for the information of His Excellency the Administrator (Sir Malcolm Fraser, K.C.M.G.), my Annual General Reports for 1888 and 1889. The presentation of the Reports for two years at the same time is due to the fact that the pressure of work at the Government Printing Office was so great during my stay in town last year, that the proofs could not be got ready for revision before I started on my winter tour; and as this could only be done by myself, His Excellency the Governor decided that it had better be left till my return.

I propose issuing a Geologically colored Map of the whole Colony at the end of the present year, as by that time I hope to have examined most of the settled country; but of the vast interior I shall only be able to fill in such information as can be gained from Reports and Maps of Explorers.

In the preparation of this Report, and in my work of the past two years, I have been greatly assisted by the work done by my predecessors. I therefore commence by giving a short Historical account of their labors, and then to briefly describe the Geographical configuration and Geognosy before entering fully into the Geology, concluding with a sketch of the Mineral wealth, and my Reports of the country examined during the past two years, which have appeared in the daily and weekly papers, but which have not yet been officially published.

I take this opportunity, Sir, of expressing my indebtedness to you and the other Government officials for the courtesy and assistance I have always received.

I have, &c.,

HARRY PAGE WOODWARD,

Government Geologist.

15th May, 1890.

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INTRODUCTION.

An Historical Account of the Geological Work up to the end of 1887.

Very little had been done in the way of a systematic Geological Survey up to this date, but when the enormous area of the country and the fact that Geologists have only been engaged for short periods are taken into consideration, both the quantity as well as the quality of the work done by them is highly creditable.

The first Geologist employed was Dr. F. Von Sommer, who, during the years from 1847 to 1851, examined the Victoria, Toodyay, and York Districts, and the country between the latter and Mount Barren. He made Geological maps and reports of these districts, but unfortunately they have not been published.

During this time two very promising and painstaking amateur Geologists developed in the Colony itself, viz. :—Mr. A. T. Gregory, C.M.G., late Surveyor General, Queensland, and the late Mr. F. T. Gregory, who lacking all special training and being in those days almost entirely cut off from the scientific world, and taking up Geology merely as a secondary consideration to help in the surveying and exploring on which they were employed, did such good work that no professional Geologist would be ashamed to own it, and indeed so accurate is their Geological map of the Colony (published in London in 1860), as I found in that portion which I examined last year, that their mapping will be retained provisionally for those portions not yet re-examined.

The Surveyor General of that time, Captain Roe, who seems to have been an enthusiastic Geologist, made a good many useful notes on his travels, and to him the preservation of the reports of these early explorers is entirely due.

Mr. H. Y. L. Brown, F.G.S., now Government Geologist of South Australia, was engaged here in 1870 and 1871. He examined and mapped in detail and reported on a strip of country about 50 miles wide, from the Murchison River to the South Coast. He also issued a special report and map on the lodes of the Champion Bay and Northampton Districts.

In 1882 the late Mr. E. T. Hardman, F.R.G.S.I., was appointed Government Geologist. He examined and reported on the Kimberley District, and published two colored Geological maps.

For a great many years the country has been greatly indebted to the Revd. C. G. Nicolay, M.A., for his indefatigable services in testing and reporting on samples for any one who was in the least doubt as to what he had found. He also started the Geological Reference Museum at Fremantle, where after long years of continual hard work he has accumulated a very good typical collection of the

rocks and minerals of this country. Moreover his work has not been confined to the Museum and Laboratory, for on several occasions he made long and tedious journeys to settle important questions as to the value of reported mineral discoveries. Being an enthusiast he neither cares for gain nor minds hardships, but only hopes that his work may prove of use and that he may do his share in solving the great problem of the formation of the earth on which we live.

Another enthusiastic worker is Mr. H. E. Victor, C.E., who for years has interested himself in collecting specimens and observing the geological formation of the country. He prepared the collection, drew up the catalogue, and wrote the Geological sketch of the country, which were sent to the Paris Exhibition of 1878.

The Department of the Surveyor General has done much in elucidating the Geology of this immense country. The Hon. John Forrest, F.G.S., F.R.G.S., and his staff have developed and carried out the plan, which seems to have been originally started by Captain Roe, of having collections made by the Surveyors; and while the present able Chief remains in office there will be no falling off in the energy displayed in this useful direction.

Among others to whom Geology is indebted is Mr. Knight, who made a large and very interesting collection of minerals and rocks, which probably formed the nucleus of the present collection in the Geological Museum; Messrs. Maitland Brown, Shenton, and others have made collections which have been sent to London at various times. Captain Mitchell, of Northampton, has made collections of the minerals of his neighborhood, and written a pamphlet on the mines giving statistics of the ore raised in the Victoria District.

Messrs. C. Moore, F.G.S., W. H. Huddleston, M.A., F.G.S., A. H. Foord, F.G.S., the Rev. W. B. Clarke, and Dr. H. Woodward, F.R.S., have written valuable papers on the Fossils and Geology of the Colony.

The reports of Mr. Hargraves and some other gentlemen, who have been employed to report on the mineral deposits, do not contain much of geological interest.

GEOGRAPHICAL CONFIGURATION.

Western Australia occupies about one-third of the whole Continent of Australia, having an area of 1,060,000 square miles, *i.e.*, about nine times the size of England, Scotland, and Ireland together. It is 1,450 miles in its greatest length and 850 in breadth, lies between 14° and 35° South Latitude and 113° and 129° East Longitude, the latter Meridian being its boundary line with South Australia, while the Indian Ocean bounds it on the North and West, and the Southern Ocean on the South.

The Coast line, which is about 3,500 miles in length, has long stretches little broken by bays, gulfs, or creeks, and has but a few islands which are scattered in patches here and there, and so has a very short coast line for the size of the country.

The Coast is rising rapidly, which accounts for the low alluvial sandy plains occurring between the sea and the ranges. These plains vary from a few hundred yards to twenty miles in width, and are interspersed with numerous salt inlets, lakes, and swamps.

The country has only been settled for about 200 miles inland, and from the information gained by explorers the interior appears to be a vast sandy table-land from 1,000 to 2,000 feet above the sea level, with here and there large areas of depression in which are situated immense salt clay pans, surrounded by low broken ranges of granitic and other crystalline rocks.

MOUNTAINS.—The mountains are not remarkable for their height, though many of them, rising abruptly from plains little above sea level, present a rather striking appearance. The principal ranges in the South-West are the Darling, Roe, and Blackwood Ranges. The Darling Range is the most important, extending almost due North and South for about 300 miles, at a distance of 18 to 20 miles from the sea, towards which it presents a steep face, and although it has no peaks over 1,500 feet in height, yet it has a more imposing appearance than the Roe Range, which runs parallel to it, but further East, of which the highest peak, Mt. William, reaches 3,000ft. above sea level. The other range, the Blackwood, has the greatest average elevation, although it does not anywhere attain a greater height than 2,000ft.

Near Albany on the South Coast is the Stirling Range, which is the loftiest range in the settled districts, and being perfectly isolated and rising from a dead level plain it is visible for an immense distance. Its chief peaks are Mt. Kyenerup 3,500, Tolbrunup 3,341, Ellen's Peak 3,420, and Willie 3,000 feet.

Some of the highest hills and ranges in the Colony are said to exist in the Northern portion of the interior, at the sources and upper part of the basins of the large rivers. They have not yet been accurately measured, but are estimated to reach the height of 6,000 or 7,000 feet above the sea level.

No volcanoes exist in the Colony, and the general appearance of the country throughout indicates a condition of remarkable quiescence even further back than the Carboniferous epoch.

RIVERS.—The principal rivers are the Fitzroy, De Grey, Harding, Fortescue, Ashburton, Gascoyne, Murchison, Greenough, SWAN, Murray, Collie, Preston, Blackwood, and Gordon. For the most part they are simply immense storm water channels which carry off the floods after the rainy season, and those that are navigable are only so in the estuarine portion, which is salt except during the time of the floods.

LAKES.—The maps show a great number of lakes in the interior, which tends to give a very incorrect idea of the country, as, except after heavy rains when they may be covered with a few inches of water, they are perfectly dry. They are in reality immense salt clay pans or marshes.

BAYS, GULFS, AND INLETS.—Although in places the Coast line is a good deal indented, this country is sadly deficient in good harbors; the only ones deserving mention are King George's Sound, Sharks Bay, King Sound, and Cambridge Gulf; the remainder being of little value, owing to the direction of prevalent winds, currents, shallowness, or bars.

CAPIES.—The Capes are Londonderry, the most Northerly point of the Colony; Levéque, at the entrance to King Sound; North-West Cape, by Exmouth Gulf; Steep Point, by Sharks Bay; Naturaliste, by Geographe Bay; Leeuwin, the S.W. point of the Colony; Howe, to the W. of Torbay; and Cape Arid, at the W. of the Great Australian Bight.

ISLANDS.—There are a great many small islands around the coast, but the only two of importance are Dirk Hartog's Island, off Sharks Bay, and Rottneet, off Fremantle.

CLIMATE.—The climate cannot be spoken of as a whole, owing to the enormous extent of the Colony. In the North there is a true Tropical climate. About the Gascoyne and Murchison Rivers there is an intermediate state of things: heavy summer rains, and a good healthy dry climate for the rest of the year; while in the South-West, the settled portion, the seasons may be divided into wet and dry, the former lasting from April to October and the latter November to March; during this, the summer, thunderstorms may occur, but are most uncertain. The annual rainfall on the coast, from Fremantle to Albany, is about 40 inches, which 50 miles inland, amongst the ranges, does not exceed 20 inches; whilst in the interior, over 200 miles from the coast, no reliance can be placed upon it, as thunderstorms of a local character are all the squatters have to depend upon.

The temperature of Perth rarely exceeds 100° in summer or falls below 35° in winter, whilst in the North the temperature is very high in summer before the wet season sets in.

During the summer months the North-West coast between Ashburton and Roebuck Bay is visited by cyclonic storms (locally called willy-willies), which do a great deal of damage.

On the South and South-West coasts there is scarcely any tide, while on the North-West and North its rise and fall exceed 30 feet.

SOIL.—In this Colony there are as good and as great a variety of soils as in any part of the world. Unfortunately only small portions are as yet under cultivation, for large tracts of the best land are either so heavily timbered or are held by persons who do not cultivate, and these facts have tended to give the place a bad name.

Cereals are grown as far North as Lat. 29° , and on the hills to the East of Perth nothing is thought of a crop of 40 bushels to the acre.

GEOGNOSY.

PHYSICAL GEOGRAPHY.

The Kimberley District occupies the most Northerly portion of the Colony, stretching from King Sound to the borders of the Northern Territory of South Australia.

The country to the East and South-East of King Sound gradually rises towards the Leopold Range. It consists of a large undulating plain of sand, sandstone, and alluvium, the latter formed by the Fitzroy River. It is broken here and there by low hills of sandstones, grits, and conglomerates of Carboniferous age. The main portion of this plain is supposed by Mr. Hardman to be of Tertiary age, but from his description of its general characteristics it would appear rather to belong to the *desert* sandstone, which is Mesozoic.

The Leopold Range, which runs N.W. and S.E., is from 1,500 to 2,000 feet above the sea level and is formed of the oldest rocks known in the district, viz.:—quartzites, altered grits, schists, and gneiss, flanked on the S.W. face by limestones, often magnesian, of Carboniferous age.

After passing the Southern extremity of this range the grassy alluvial plains disappear, and the country becomes rocky and hilly. To the Northward is the Müller Range, a spur of the Leopold running in a North-Easterly direction, while in a South-Westerly direction there is an undulating sandstone country, from which rise numerous low-rounded or conical hills, mostly of granite or metamorphic rock. Further South can be seen rugged limestone hills succeeded by flat-topped hills, apparently of Carboniferous age, which seem to rise to a considerable height, and form quite prominent objects in the landscape.

From the Margaret Plain, 300 feet above sea level, the country rises rapidly to the Albert Edward Range, formed of Devonian rocks, in which peaks attain an elevation of 1,170 to 1,650ft. Between the Margaret River and this range are a series of slates, grits, and sandstones, which in places form lines of hills that are intersected by numerous quartz reefs. The principal gold-bearing reefs have been found in these lines.

Eastward of this district lies the Great Antrim Plateau, which extends across the borders into the Northern Territory of South Australia. It consists of a series of gently undulating hills, with here and there a rough face of rock, and here and there a deep well-marked valley extending as far as the eye can reach. It is of great interest as it is the only great lava flow known in Western Australia.

Both to the North and South of this table-land the Devonian and Carboniferous rocks are well developed, but on following the Ord River further North the crystalline rocks again outcrop at Mount Pill and the Carr-Boyd Range; still further North these latter rocks disappear beneath the great sandstone formation, which extends as far as the coast, where they once more reappear in the cliffs and bold headlands, and are generally capped by horizontally bedded sandstone. This formation extends all the way down the coast from Cambridge Gulf to King Sound.

To the South of this district stretches the Great Sandy Desert of Warburton, an inland plateau, believed to be about 5,000 feet above the sea. It is covered with parallel light red sand ridges rising to 50 feet in height, and about 400 yards apart; these rest upon clay and gravel, the pebbles of which are smooth and waterworn.

Several large rivers have their sources on the Western edge of this plateau and cutting deep gorges through the upper horizontally bedded rocks expose the underlying crystalline rocks, across the strike of which they have cut their

channels. These water-courses flow towards the N.W. through deep gorges cut in the sandstone-capped crystalline rocks, then through flats bounded by rough sandstone ranges, and on by deep ravines through rough broken hills of schists, slates, sandstones, quartzites, conglomerates, and amygdaloids, containing trap dykes, into large alluvial plains, with here and there bold massive hills of amygdaloid and small peaks of quartz, granite and ironstone, around which soft calcareous slates often rise to the surface but never form hills much above the level of the plain. These plains extend to the sea coast where they are fringed by mangrove swamps, except where trap rocks extrude and form a bold rocky coast. The amygdaloids in many places split up into rough blocks, which become red or black on the surface, and then present the appearance of a huge heap of stones; without a trace of soil or vegetation. They contain vast numbers of agates, calcite crystals, and other enclosures, so that it would be advisable to prospect the streams running through them, for precious stones.

Further to the S.W. the rivers rise in a large range, which runs N.W. and S.E., and rises 2,800ft. above sea level and forms the water parting between the rivers flowing W. and those flowing N.W. This range is formed of crystalline rocks capped with horizontally bedded sandstone. It presents bold cliffs of from 500 to 700ft. in height to the open plain or lower table-land lying to the North, which is occasionally broken by isolated sandstone hills often containing jasper and agate, while the rivers expose beds of conglomerate and breccia beneath the sandstone.

This section of the country has not yet been examined geologically, so it is impossible to speak decidedly as to its age; it is, however, probably Carboniferous or Devonian. Below this table-land there is another, at about 1,000 feet above sea level, having a still more broken surface, covered with small ranges and isolated hills, capped with sandstone, (as at King's Pyramid), between which the rivers open out into good-sized flats. The coast ranges, rising about 700 feet above the sea, are rough broken hills, composed of hornblende schists, quartzite, conglomerates, shales, limestones, amygdaloids, with diorite, granite, actinolite, and tourmaline dykes, and lodes of ferruginous copper ore and ironstone, quartz and jasper veins. These hills are generally separated from the coast by large alluvial plains, intersected here and there by huge outcrops of rock, forming a bold rocky coast, as at Cossack, where the hornblende rocks are largely developed, and are traversed by veins of actinolite and tourmaline, which latter mineral shows as black streaks down the faces of the cliffs, and was at first taken for coal, but as it would not burn was put down as something volcanic, and so gave rise to the general idea that this district is all volcanic.

Large ferruginous copper lodes occur all over the district, some of which carry from 30 to 40 per cent. of the metal, but the mass of the lode stuff is iron, and in some of the specimens gold is plainly visible, and, judging from the assays, would be well worth working. Small lodes of galena, rich in silver, have been found near Roebourne, though up to the present they have not been worked. The galenas and cupriferous gossans of this district are well worth testing.

Gold is now the all-absorbing attraction of this district, for rich alluvial deposits have been discovered about Roebourne and over 200 miles to the Eastward; it occurs for the most part in thin alluvial deposits, and in some cases has actually been found sticking out of the ground, so shallow was the wash. Recently the deeper ground has been prospected with great success. Several very rich reefs have also been found in the neighborhood of Roebourne, in the low hills standing up out of the alluvial flats or rising just to the surface of the calcareous clay slates. The gold in these lodes is associated with sulphide of antimony, which in some places is so abundant that it would be well worth starting some auriferous antimony mines.

At present nothing is known geologically of the country between this and the Lyons River, a tributary of the Gascoyne, which takes its rise in the great flat-topped range that forms the water parting between those rivers that flow to the North-West and those that flow to the West. This flat-topped sandstone table-land is about 1,500ft. above the sea. It is broken in many places by deep gullies which the streams have cut down to the older rocks beneath, and in other places by bold masses of crystalline rocks forming ranges rising as much as 3,500 ft. above the sea level. On descending the Lyons River the country is found to be entirely different; limestone, proved by its contained fossils to be Carboniferous, is met with, and still lower down the river, near its junction with the Gascoyne, carboniferous shales occur. Overlying these beds are white and red fossiliferous sandstones, and chalky limestones of Cretaceous age, which, to the South of the river, are capped by beds of sandstone and coarse grits.

About the source of the Gascoyne the rocks are gneiss, schists, chloritic and clay slates, with quartz reefs and dykes of porphyry, striking a little to the E. of N., while along the bed of the river sandstone and travertine deposits occur, the latter often cementing the river gravels and forming a conglomerate, in which water can nearly always be found close to the surface.

The plains, stretching away in both directions from the upper courses of the Gascoyne, are for the most part sandstones and clay shales strewn in many places with fragments of crystalline rocks and quartz, which also occur as low isolated ridges here and there.

Below the junction of the Lyons and Gascoyne Rivers a belt of Mesozoic rocks is met, and this, nearer the sea, is covered by a large deposit of ferruginous sandstone, containing plant remains, which is in its turn overlaid by a recent deposit of red drift sand that extends to the coast.

The Murchison rises in the edge of the broken table-land amongst ranges of crystalline rocks about 1,500 feet above sea level. Many of these hills are capped by horizontally bedded sandstone intersected by numerous quartz reefs. They are surrounded by large alluvial flats of red clayey loam and sand which are broken in places by bald red granite hills, evidently intrusive, which appear to extend in lines or belts across this part of the country. The whole course of this river lies through country of nearly the same character, viz., large flats of clay and sand flanked by metamorphic hills containing quartz reefs and dykes of diorite, and generally capped with ferruginous sandstone. In the bed of the river sandstone and travertine are of constant occurrence, in some places associated with large quantities of salt. At its lower bend the river flows between hills of sandstone, breccia (containing fragments of quartz and jasper), and fine-grained white and red sandstone overlying conglomerates and greenish and white micaceous clay, probably Carboniferous, as this formation definitely makes its appearance in the form of shales immediately above the patch of crystalline rock that out-crops for a few miles along the course of the river, and contains the mineral lodes, of which the best known is the Geraldine Lead Mine.

From this point the country is in general undulating, the highest hill not attaining more than 700 feet, and the rock consists of fine-grained cretaceous sandstone. On approaching the sea coralline and shelly limestones make their appearance, and by the mouth of the river there are some coast sand hills.

Peron's Peninsula and Dirk Hartog's Island, in Sharks Bay, are composed of coralline chalky limestone, and calcareous sandstones containing many fossils of Eocene age.

The Victoria District has been the great centre of the mining interests of the Colony. It is situated between the Murchison and Arrowsmith Rivers. Most of

the work that has been done up to the present has been in that portion lying between Geraldine (on the Murchison) and Geraldton (Champion Bay).

The country consists of a series of flat-topped hills or table-lands of clay sandstones, and limestones of Cretaceous and Oolitic age. These, in many places, are covered by sand plains. Where streams occur they have cut through the newer rocks, removing large portions and exposing the underlying crystalline rocks, of which granite is the most abundant, the others being chiefly mica schist, gneiss, and quartzite, with numerous dykes of diorite, granite, and felstone.

In these rocks occur rich lodes of lead and copper, which may be traced for several miles on the surface by means of their clay ironstone caps. Their strike is about 30° E. of N. and their dip 80° to 90° N.W. Numerous quartz reefs are found as cross courses, and at the point of their intersection the true or "right" lodes have always proved extra rich, although the reefs themselves do not carry any metal. As none of these mines are now being worked it is impossible to find out either the relative ages or the relations of the veins to one another.

The most remarkable thing about this district is the finding of lead so abundantly in such a highly altered country, and this can only be explained on the assumption that the infilling of the lodes took place at a date more recent than that of the metamorphism of the rocks.

Further East the Mesozoic rocks are well developed, forming a great sandy table-land, 40 miles wide, through which the Greenough has cut a channel, which presents fine sections of these rocks, as well as of a series of Carboniferous rocks beneath them. The Greenough River rises far to the Eastward in the Murchison district, among low crystalline hills, often capped with desert sandstone, and bare granite hills, which rise out of the large alluvial plains in the upper part of this river basin. In its bed, just as in the Murchison, there are found sandstone and travertine conglomerate (which is often almost a magnesian limestone) and is here, too, a surface water-bearing rock. The river passes close by the highest peak of the district, Tallering, where the rocks are mostly schistose with numerous quartz and ironstone reefs, though in the gorge cut by the river the Carboniferous and Mesozoic rocks appear, and these are largely developed to the N.E. of the Greenough Flats, where the river valley expands into a wide alluvial flat between two lines of sand-covered limestone hills. The river discharges itself into Champion Bay through the high sand dunes which stretch along the coast to Geraldton.

The Irwin rises about 50 miles from the coast, in the crystalline range of hills of which Peterwangy is the highest. These hills are partially covered on their spurs by large deposits of red clay, clay ironstone and ferruginous sandstone, and the river has made a deep channel through these softer rocks exposing the Carboniferous series beneath, which here rest unconformably upon the old crystalline rocks. The Carboniferous series is here represented by beds of clay, claystone, micaceous clays, limestones, sandstones, and shales with gypsum, iron pyrites and coal seams, and must be of considerable thickness as there is a steady dip throughout to the N.E. Through these rocks the river has cut a gorge showing cliff sections 200 to 300 feet in height and on the top of which the ferruginous sandstones and conglomerates are seen to rest unconformably, and, where breaks have occurred in the carboniferous rocks, they descend to within a few feet of the river. Lower down the river, where the clay beds at the bottom of the series make their appearance, the valley opens out into a large flat surrounded by broken flat-topped hills and undulatory country of Mesozoic age, of which the surface is covered by sand all the way down to the coast, when the coralline and sandy limestones make their appearance as coast hills.

The Coast line from the Murchison to the Moore River consists for the most part of Tertiary and Recent deposits, chiefly marine sand-drifts, shell gravels, and

marls, with here and there salt lagoons and swamps separated from the sea by ridges of sandstone or limestone, which often reach 300 feet in height. Parallel to the shore are a series of flat-topped ranges, rising 600 feet above the sea, built of horizontally bedded sandstone, ferruginous claystone and mottled limestone containing fossils of Mesozoic age. Further South, on the Moore River, are found sandstones, chalky limestones with flints, and ferruginous sand stones, containing fossils of Cretaceous age. Here numerous stalactitic caves and underground water-courses exist.

Inland are undulating sand plains, rising to 800 feet above the sea level, of coarse silicious sands, clayey sands, clay limestone, and ferruginous sandstone, with here and there in the hollows heavy impermeable clay, which, collecting the water draining from the overlying sands and sandstones, forms swamps. In some places, as between the Yarra Yarra Lakes and the South branch of the Irwin, called the Lockier River, there are low ranges of crystalline rocks, in which more rich patches of mineral lodes occur; these have not been worked at present, as the expense of cartage over the sand plains would consume all the profits.

A little further Eastward is another low range of crystalline rocks, evidently the Northern extension of the Darling Range, though here named the Herschel Range. It extends from Yarra Yarra Lakes Northward to the Murchison, and seldom attains a greater height than 1,000 feet. It forms the Eastern boundary of the Carboniferous and Mesozoic rocks, and is capped in many places with deposits which may or may not belong to the same series, but which it is impossible at present to map separately.

Eastward of this an undulating and gradually ascending plain is found, at first mostly sand, with here and there hills often capped with a thin layer of ferruginous sandstone, then fine clay flats broken by ranges of crystalline rock having numerous quartz reefs and often capped with sandstone. Between these hills are large alluvial flats containing deposits of gypsum, potash, and magnesia, with salt swamps in places, and here and there bold masses of granite, sometimes rising to a considerable elevation, at others only just appearing above the surface.

The Central and Eastern Districts embrace the coast line between the Moore and the Murray Rivers and include the Darling Range. This coast line comprises a range of cliffs of coralline and shelly limestones, and calcareous sandstone containing Recent and Tertiary shells, and, where the rivers have removed these beds, large drifting hills of marine sand occur. These formations are mostly overlaid by a white silicious sand often rising into ridges 50 to 100 feet high, and which inland attain an elevation of 300 feet. This sand has been proved by well sections to be, at a short distance below the surface, a compact red sandstone destitute of organic remains. It sometimes reaches 40 feet in thickness. Beneath this sandstone are found calcareous sandstones and gritty conglomerates, or, as near Perth, as well as in other places, oyster beds and other estuarine deposits, proving it to be of very recent date.

Immediately underlying these coast beds, and running in a parallel line between them and the Darling Range, are beds of clay supposed by Mr. Gregory to be of Cretaceous age, and to be an extension to the South of the beds of this age, which are exposed at the Moore River, and extend as far South as Gingin. On the Western edge of this clay chalybeate springs rise. A trial bore made in this formation struck, at a depth of 170ft., a stratum of black shale containing fragments of coal or lignite, and a great deal of iron pyrites.

Overlying this clay, and resting against the foot of the hills, are beds of white sand, ferruginous conglomerate, and decomposed rock debris, in which have been found many pieces of different ores and fragments of garnets and other crystals.

Flanking the main granitic range are beds of clay slate, mica schist, and flaggy sandstones, which, near the Murray, dip 60° to 70° to the W. and strike 10° E. of N., while on the Canning the strike is N. and S. and the dip vertical. To the North these beds change into micaceous sandstones, containing quartz veins, numbers of which, together with diorite and porphyry dykes, occur along the Western face of this range and are often associated with metallic ores, though none large or rich enough to pay have at present been found.

This range which rises to 1,800ft., is principally composed of hard crystalline rocks, *e.g.*, granite, syenite, porphyry and gneiss, containing numerous dykes of granite, diorite, and serpentine, quartz veins and ironstone lodes, covered for the most part with cappings of red clay and clay ironstone which in places rest on large deposits of very pure kaolin, ferruginous sandstones, grits and conglomerates, nodular clay ironstone and sand, sometimes as much as 40ft. in thickness, and as high as 800ft. above sea level. These beds have been classed as Devonian, but as there are no sufficient data to confirm this view they may as well for the present be considered provisionally as Mesozoic.

On penetrating well into the range the character of the rocks changes, granite almost disappearing and being replaced by crystalline schists, often of a comparatively soft nature, but still traversed by numerous quartz reefs and ironstone lodes. Along the lines of change which follow the strike of the rock, the rivers cut their channels and form large flats.

At the North bend of the Avon the rocks are gneiss and mica schist, and contain quartz veins and several rich lodes of magnetic iron. This ore has been tested and proved to be very rich, and to yield iron of great purity.

To the Eastward the country is chiefly a large undulating plain of sand, which generally contains a large percentage of clay and sometimes small nodules of clay ironstone, while the hills are mostly capped with ferruginous sandstones. Out of this plain rise isolated hills of metamorphic and granitic rocks, the former often forming bold ridges or hill masses sometimes capped with horizontally bedded sandstones and conglomerates, while the latter only just appear above the surface in some of the higher parts of this rolling plain.

More to the East the sand almost entirely disappears, giving place to large clay and loam flats with bold bare red granite hills and extensive red clay alluvial plains, with salt and gypsum deposits which continue to about 119° East Longitude, when a line of low ranges makes its appearance containing numerous quartz reefs and ferruginous lodes, some of which have proved very rich in gold. The country here is a good deal broken and of comparatively slight elevation, unlike most of the interior, which is a high table-land, and this may be the result of extensive denudation arising from the fact that most of the drainage of a large portion of the interior passes over this area, which would also account for the ridges of the older rocks beneath being exposed.

A marked feature on the S.W. coast is the chain of tidal lakes and inlets and swampy alluvial deposits which follow the coast, sometimes connected with the sea, and at others separated by the sand-hills. The bars across the mouths of most of the rivers keep them fresh for a great part of the year, although they are not running rivers, but merely estuaries with the water standing at sea level. There is plenty of evidence to prove that this coast is rising rapidly, in addition to the fact, that many old colonists remember when land at Fremantle, now quite above the water level, used daily to be covered by the tide.

The South-Western division is almost identical with the foregoing until Bunbury is reached, when the coast turns sharply to the West forming Cape Naturaliste. Between this point and Cape Leeuwin there is a line of ranges of crystalline rocks, running parallel to the Darling Range; they are flanked towards the sea by limestone cliffs. Between the ranges—a distance of some 30 miles—

is a stretch of country consisting of sand, loams, clays, and gravel in which lignites of good quality have been found.

This Southern portion of the Darling Range is of a highly crystalline character, the rocks being mostly granite and gneiss with dykes of diorite and feldspar, and quartz veins, all of which, as in the Northern section, are capped with deposits of clay, clay ironstone, and sandstone.

Columnar Basalt makes its appearance at Bunbury and further to the South at Cape Beaufort, as well as in several places between these points, but to what extent these flows continue cannot be determined on account of the overlying rocks.

From this point to Albany the coast has bold granite headlands indented by a number of inlets into which the rivers draining the South coast flow, often forming large alluvial deposits. Patches of limestone occur in places, while, higher up, the sections exposed by the streams show the crystalline rocks overlaid by clays and clay ironstone deposits.

North of Albany stands the Stirling Range: it is about 50 miles long, runs E. and W., and attains its greatest elevation in Kyenerup, a peak rising 3,500 ft. above the sea level. The rocks of this range are not of so highly altered a character as is generally the case in this Colony; they consist of quartzite, sandstone, ferruginous slaty sandstones, and slate, with quartz reefs striking E. and W., with a variable dip. The country between this range and Albany is entirely granite, large masses of which rise through the sand, with which a good deal of it is covered. At the foot of the Stirling Range gold has been found, which gave a good return on assay, but was not worked at a profit.

Eastward the coast presents a series of bold granite headlands as far as Cape Arid, the granite being overlaid by fossiliferous Mesozoic rock which extends far into the interior, till it disappears beneath Giles' Great Victoria Desert.

From Cape Arid to the boundary of the Colony a great mass of limestone rises, presenting an almost vertical face, from 300 to 400 ft. in height, to the Great Australian Bight. This was probably formed by a great upheaval from the Southward in recent times, the strain causing one great fault, the line of which now forms the line of cliffs.

This great table-land extends some 200 miles into the interior: it has no rivers, but the rainfall soaks into the porous limestone and is discharged at the base of the cliffs. The rock is very interesting from a geological point of view, being very largely composed of fossils.

GEOLOGY.

Hitherto it has generally been imagined that the formations to be found in Western Australia were limited in number, and that the rocks for the most part were either granite or sand; but that this was quite erroneous will be seen by examining the table of strata given below, showing the various formations now

known, and which will probably be much extended when all the country has been thoroughly examined.

TABLE OF GEOLOGICAL FORMATIONS (*Sedimentary.*)

<i>Cenozoic.</i>	Quaternary.	<i>Recent</i> (<i>Holocene.</i>)	{ Alluvium of lake basins and river valleys, river gravels, estuarine deposits, gypsum and salt beds, sand dunes, sand plains, raised beaches and shell marls and gravels, and brick earth.
		<i>Pleistocene.</i>	{ Ancient river gravels and lake beds. Lower estuarine deposits, shelly limestones and sandstones of the coast.
	Tertiary.	<i>Pliocene.</i>	{ Ferruginous sandstones and variegated clays.
		<i>Miocene.</i>	{ Not known.
		<i>Eocene.</i>	{ Coralline and chalky limestones with flints, calcareous and ferruginous sandstones and grits.
<i>Mesozoic or Secondary.</i>		<i>Cretaceous.</i>	{ Chalky limestones with flints, sand, ferruginous sandstones and limestones, ferruginous nodular clay stones, sands, clays and mudstones.
		<i>Jurassic.</i>	{ <i>Oolites</i> :—Oolitic limestone, clay ironstone, ferruginous sandstone, grits and conglomerates. <i>Lias</i> :—Ferruginous and variegated limestones, clays and ironstones.
<i>Palaeozoic or Primary.</i>		<i>Carboniferous.</i>	{ Sandstones, grits, conglomerates and ironstone, limestones, mud-stones, micaceous clays and shales, with iron pyrites, gypsum, and coal seams.
		<i>Devonian.</i>	{ Shales, indurated slates, limestones, coarse grits, and conglomerates.
		<i>Silurian and Metamorphic.</i>	{ Clay-slate, limestones, marble, dolomite, sandstones, quartzites, and conglomerates.
<i>Azoic?</i>	{	<i>Archæan</i> (<i>Metamorphic.</i>)	{ Slates, schists, serpentine, quartzite, gneiss, granitoid, and garnet rocks.

IGNEOUS ROCKS.

<i>Volcanic.</i>	Basalt, dolerite.
<i>Plutonic.</i>	Felstone, diorite (greenstone), syenite, granite, porphyry, amygdaloid.

The Igneous Rocks are of all ages, and have resulted from the solidification of molten matter that has been forced upwards from great depths in the interior of the earth, and has risen either through pre-existing fissures or faults, in which case it forms *dikes*, or it has been intercalated between beds of sedimentary rock, or it has formed large irregularly shaped bosses. These rocks are usually divided into two classes, according to the circumstances under which they have become solid; those which have cooled down on or near the surface are called Volcanic, and those that have solidified at some depth Plutonic. They are often composed almost entirely of silica, and seldom contain less than fifty per cent. of that mineral.

MINERAL VEINS.

Mineral veins are deposits of mineral matter that occur in rocks of all ages, usually in faults, but sometimes in other fissures, in both stratified and eruptive rocks. Those containing metallic ores are termed lodes, and they occur most frequently in the metamorphic archæan rocks at or near their junctions with Plutonic rocks.

RECENT AND TERTIARY ROCKS.

Alluvium of Lake Basins.—All over the interior on the great table-land, there are a series of what are called lakes, though they are in reality nothing more than large salt flats or boggy clay pans, almost on a dead level, which drain into one another, and eventually, if the season has been wet enough, discharge themselves into the upper courses of some of the numerous rivers which cut through and drain the range that forms the Western boundary of the great plateau; but this rarely happens, as they present such an enormous area for evaporation. One consequence following this is that these large flats nearly every year receive a fine covering of clay upon which the salts contained in the water crystallize out to be redissolved and added to from time to time, till in some places, which may be a little lower than the rest, or where some obstruction occurs to the flow of the water, very large deposits of salt are formed. These lakes are surrounded by red clay flats, which also contain a great deal of salt,—in fact the whole interior is salt; and although such large quantities of rain have fallen since the last submergence as to destroy all traces of the marine deposits that must have been left, yet as the water does not find any outlet to the sea, but is lost by evaporation from the clay pans, the country remains almost as salt as when first elevated from the sea.

On the North coast there are some extensive alluvial deposits, not always in the river valleys themselves, but sometimes following the sea coast, and in other places what was once the bed of the river. They are not as a rule of any great thickness, as outcrops of rock are frequent. It was in one of these large plains that the great gold bearing reefs of Mallina were found.

River Valley Gravels and Estuarine Deposits.—These are often very similar in character to those of the lake basins, but with this great difference, they rarely contain salt. They are best studied on the Upper Murchison where large clay and loam flats, often many miles wide, occur. They have probably been formed in the same manner as the lakes, but having been better drained the salt has been carried away by the rivers. Certain tracts, however, still contain much salt, which gets replenished from time to time by large discharges of salt flood water from the lakes at the source of the river.

All the rivers North of the Greenough form these large flats, which are surrounded by flat-topped ranges—the remnants of the whole table-land, that having no range for support on its Western face, has been cut up by these numerous water-courses far away into the interior; in fact the greater part has in many places been removed, only leaving these flat-topped hills dividing the river basins to prove the immense amount of denudation that has taken place.

In the South the rivers do not form such large flats, but, instead, small ones of clay, loam, sand, and gravel throughout their courses, and these are very fertile. Below the ranges large deposits of brick earth are found.

The Estuarine deposits of the South are of very slight account, for the rivers are comparatively small, have but short courses, and immediately on emerging from the gorges they have cut in the ranges discharge themselves into the arms of the sea, which run up through the low-lying land from the coast to the foot of the ranges. Moreover, they are but seldom flooded by excessive rainfall and so bring down very little detritus.

Further North, where there are periodical tropical and semi-tropical floods, the rivers bring down large quantities of mud which they deposit near their mouths, forming, excepting where coastal currents interfere, a kind of swampy delta on which the mangroves thrive. At the mouth of the Ashburton and in some other localities, the river mud rapidly disappears in the sand that the sea is so largely accumulating in those places.

Salt and Gypsum Deposits.—These have been mentioned under the heading of Lake Basins: it is however worth noting that gypsum occurs in the form of beautiful crystals (*selenite*) in some of the clay pans in the interior.

Sand Dunes.—These occur almost everywhere along the coast by the river mouths, or where the land is low. They sometimes, as at Geraldton, reach a considerable height, and are a source of trouble as they are constantly travelling unless kept carefully bushed or planted. Very often excellent water can be obtained beneath them, although that under the neighboring flats may be bad.

Sand Plains.—These are the characteristic features of Western Australia. They extend from one end of the Colony to the other, and though produced in several ways are all equally objectionable and useless. The great sand plains of the interior are often twenty to thirty miles across, but containing in places a good deal of clay and iron which cement the grains of sand together, and there being a fair rainfall they are covered with hardy vegetation, and during the two spring months are perfectly gorgeous with flowers—with such a blaze of blossom as could hardly be equalled anywhere in the world. Consequently they are not nearly so bad as the great tracts of sand of the South-West of Queensland and a large portion of the Northern Territory. They result from the disintegration of the desert sandstone, which forms the table-land of the interior of Australia.

The sand plains which follow the coast in the Southern portion of the Colony extend up to the ranges, and cover most of the lower ground. The sand here is much looser than in the interior, and is either of marine origin, remaining from the last elevation of the land out of the sea, or is derived from the weathering of the calcareous sandstones so plentiful along this part of the coast.

Raised Beaches.—These have been noticed, by the late Mr. Hardman, near Roebuck Bay about 10 to 15 feet above the present sea level. One extends nearly 25 miles inland, and is from 12 to 18 miles wide. Its surface is covered with salt grass and samphire. Recent marine shells are found here and there, and in sinking a well a shelly deposit several feet in thickness containing specimens of existing forms was passed through.

Shell Marls and Gravels.—These are of frequent occurrence along the coast.

Ancient River Gravels and Lake Basins.—These are found in several places in the ranges of the South. They are similar in character to the deep *leads* of the Eastern Colonies. They contain pipe-clay and ferruginous sands, gravel, and clay. It is reported that *Diprotodon* bones have been found in one of these near Bridgetown.

Lower Estuarine Deposits.—These beds occur as far inland as Perth, where, in sinking wells near the river, large quantities of oyster and other shells are met with, which proves, beyond a doubt, that the Swan was formerly a much larger arm of the sea than it is now. The oysters must have been exterminated by the silting up of the mouth of the river, which prevents the influx of salt water and allows it to be fresh or brackish for a large part of the year. The deep holes in the Swan to the West of Perth are probably due to the fact that a large subterranean water supply has dissolved large caverns in the limestone beneath the bed of the river, which has caused subsidence in these places.

Shelly Limestones and Sandstones.—These occur all along the South-Western coast and contain fossils identical with living forms, which in many cases even

preserve the nacre of the shells. They form the great mass of the cliffs from Geraldton to the Vasse. They are often capped with sand dunes, and in all probability overlie some of the older Tertiary rocks—a problem that still has to be solved.

Ferruginous Sandstone and Variegated Clays.—Mr. Gregory reported that these cover a large extent of country on the Lower Gascoyne. He found no fossils in them except *Banksia Cones*. They are probably Upper Tertiary, though they may be still more recent.

Coralline Limestones.—These form the lower beds of the coast limestone, and contain a great many fossils of Eocene age, some of which were sent to England a few years ago to be described. The beds at Sharks Bay and on the islands there are probably of the same age.

The *Clays, Ferruginous Sandstones, Grits, and Conglomerates* between the limestone hills and the ranges probably belong to this older Tertiary Series, as well as the ferruginous conglomerates which rest unconformably upon the Cretaceous rocks to the Southward of Champion Bay.

Crystalline, Coralline, and Chalky Limestones with Flints.—The beds extend the whole length of the Great Australian Bight and for 150 miles inland. They present a bold vertical face to the sea, the cliffs being of great height and evidently along the line of a fault.

Cretaceous.—These beds consist of chalky limestones with flints, sandstones, and ferruginous sandstone, conglomerates and clay, and are well developed in the flat-topped coast range from Gingin to the Northward, and in places contain many fossils. The sandstones, ferruginous claystones, and grits of this series extend to the Eastward, capping the ranges and large table-lands of the interior. This formation is probably the Western extension of the great desert sandstone formation of the Eastern Colonies, where very similar rocks form the uppermost beds of the great artesian area. These rocks are apparently destitute of organic remains, but as they rest conformably upon the Cretaceous rocks both here and in South Australia they have been classed with them: it is however highly probable that they are of a more recent date, having possibly been formed shortly after the elevation of this Continent, when, as the surface must have been almost a dead level, little if any denudation would have occurred, though the upper beds would have been altered and the organic remains destroyed *in situ* by the vegetation aided by the action of the weather. That in places these beds are of terrestrial origin there is not the slightest doubt, as in the quartzite beds, that cap them in some parts of South Australia, vegetable remains have been found, and in other places all the indications point to a swampy or lacustrine source. In the same formation have also been placed the ferruginous sandstones and clays, nodular concretionary clay ironstones, pipe-clay, and sand, which almost completely cover the ranges of the South-Western portion of this Colony. It is difficult to account for these beds except on the supposition that they are the *débris* of a great formation that once covered the whole of this district, but which has long since been denuded and partly redeposited. The roots of the large trees which flourish upon it have helped in the work of disintegration, and at the same time have prevented its being entirely washed away by the rainfall, as is proved by the fact that wherever the land has been cleared but not ploughed, so that the rain cannot sink into the ground, deep gullies are very rapidly cut out.

Both here, and in other places, a great deal of work is done, vastly altering the appearance of the country, by what may appear to many people at first sight a perfectly ridiculous agency, viz., the white ants; but after passing over the plains, or through the thickets, where their hills are so numerous that it is difficult to drive amongst them, the immense amount of their work can be better appreciated. The clay cemented with resinous matter with which they build their

nests is as hard as brick, and when these fall to pieces they form clay flats almost impervious to water, and so hard that it will bear a great deal of traffic without being cut up. The work of these insects can be studied in all stages, first in the thickets where they are commencing work, then in the more open country where they have got the upper hand of the timber, next on the plains where half the hills will be found deserted, and lastly on the clay flats where they have almost entirely disappeared, and the scrub has begun to grow again. Another remarkable thing about these nests is the amount of iron they contain, for when a tree has been burnt in which they have built a nest, there will be found at its base a mass of iron clinker, looking just as if it had come out of a furnace.

Jurassic.—These underlie the Cretaceous rocks North of Champion Bay, and are represented by oolitic limestone, clay ironstone, and ferruginous sandstone, grits, and conglomerates in many places containing fossils. Connected with these beds are some of liassic age, from which a series of fossils were sent by Mr. Clifton to Mr. Sandford, in England. They were all supposed to have come from Sharks Bay, and were described by Mr. C. Moore, F.G.S., who says that the rocks in which they are imbedded are ferruginous and variegated limestones, clays, and ironstone, very similar to those of the same age occurring in England. Mr. Shenton also sent a large collection of similar fossils to the 1862 Exhibition in London. Both these collections have, unfortunately, been lost.

PALÆOZOIC OR PRIMARY.

Carboniferous.—These are the newest rocks of this great series at present ascertained to exist in the Colony. They were first discovered by Mr. Gregory, on the Irwin River, and later on by him on the Greenough, Murchison, Gascoyne, and Lyons Rivers; in all of which localities they are exposed in the beds of the rivers, where the superincumbent Mesozoic rocks have been cut through. On looking at the map, it will be seen that this formation must consequently cover a considerable area in a Northerly direction. The rocks of this series are sandstone grits, and conglomerates with ironstone; and limestones, mud-stones, micaceous clays and shales, containing iron pyrites, gypsum, coal seams, and Carboniferous fossils. Mr. Hardman has mapped beds of this formation in the Kimberley District, where he collected a series of Carboniferous limestone fossils, but he did not report any coal seams.

Devonian.—Indurated slates, limestones, coarse grits, and conglomerates of this age occur in the Kimberley District, resting unconformably on the Silurian Rocks. No fossils have as yet been found in them.

Silurian.—To this period have been ascribed those clay-slates, limestones, sandstones, quartzites, and conglomerates and other old rocks, not containing any organic remains, which are not highly metamorphosed. They occur in many places throughout the Colony, forming large ranges, but have not been mapped at present, for they are so intermixed with the crystalline rocks that the work is very intricate and will occupy a great deal of time.

Archæan and Metamorphic.—These rocks are by far the most common in the country, and will doubtless prove to be of even far greater extent than is now thought. Up to within the last year or two they were supposed to obtain their greatest development in the South-West corner, while the North and interior were imagined to be one vast plain of sand. Fortunately both these inferences prove to be altogether incorrect, as in the South-West rock is rarely seen, except in the channels cut out by the river, the higher grounds and plains being covered with thick deposits of clay and gravel, in which gigantic trees requiring a deep soil flourish; while in the interior range after range of this old formation is being discovered, and although often capped with thin layers of

desert sandstone the country cannot be said to be entirely covered with this latter, yet until reliable information can be obtained it has to be so mapped.

These rocks form the main ranges of the Colony, and wherever explorations have been made they have been found in broken portions of the table-land or standing up as low rugged ranges upon it. It is amongst these, in the softer belts of country that are traversed by many dykes, that the chief mineral deposits occur, as at Yilgarn, Northampton, Roebourne, and Kimberley. In these districts the rocks have been greatly decomposed and altered by thermal waters and steam at the time of the deposition of the lodes, and later on by the heat evolved by the oxidation of the metallic sulphides.

The Hornblende Rocks of this Colony are very characteristic. They are met with most abundantly from North to South and vary immensely in color, structure, and external character; some at first glance have the appearance of clay-slate but on fracture exhibit a structure similar to diorite, while others again only contain green grains of that mineral disseminated throughout a quartz matrix, and these are continually being mistaken for copper and nickle.

IGNEOUS ROCKS.

Volcanic.—These rocks only occur at one or two places in the Colony. At Bunbury and Cape Beaufort columnar basalt occurs, and though only exposed at the coast it probably extends inland under the modern Tertiary beds. A large volcanic deposit is met with in the Kimberley District, forming a great plateau extending into the Northern Territory of South Australia.

Plutonic.—These rocks occur throughout the Colony amongst the crystalline rocks, which they have displaced and metamorphosed. The granites are seen most abundantly in a belt of country running North and South about 150 to 200 miles inland, where rising out of the alluvial plains they form bold red isolated hills.

Trap rocks, usually diorite, are found all over the Colony; their caps often split up and weather into rounded masses having a waterworn appearance, owing to the corners being first disintegrated, then exfoliated, which eventually causes the formation of rounded boulders.

Amygaloids are met with in great variety in the North-West, where they form huge rugged hill masses, upon which it seems nothing will grow. Both the matrix and the enclosures vary much in different places; the latter are most commonly agates and calcite.

[The next Annual Report will, if possible, contain a list of the Minerals and Fossils of the country.]

MINERAL WEALTH.

Until quite recently this Colony was considered to be destitute of mineral deposits of any value, with the sole exception of the rich deposits of lead and copper in the Northampton district, that had been found and worked in its early days. Beyond these nothing appeared to exist of sufficient value to be worth working. Now it is known that this is a rich mineral bearing country from North to South, and every day news of fresh discoveries of gold and other valuable metals is coming in. There are, however, two great obstacles standing in the way of these discoveries being immediately turned to account, viz. :—want

of capital, and the construction that has been put on the Mining Regulations. Of these the first will be removed as soon as the outside mining world is assured of the genuineness of these finds, and that there is really a good field for investment here; and the second as soon as the Government strictly enforces all its regulations, as up to the present it has been too lenient, and of this advantage has been taken, to the detriment of the real interests of the Colony, both in the floating of companies, and by the holding of areas without fulfilling the labor conditions.

GOLD.—Gold is said to have been first found in this Colony in 1688 by the Dutch buccaneer, Dampier, after whom the North-West coast was named. He spent a good deal of time in that year in searching for the precious metal, and that he met with success seems to be confirmed by the fact that on some of the old Dutch charts this coast is marked "*Provincia Aurifera*," and also that in 1888, just 200 years later, rich alluvial fields have been found in the same locality, with gold almost on the surface.

For a considerable time after the foundation of this Colony, it was thought that gold would never be found here, but in 1868 small quantities were discovered in the alluvium by Peterwangy Hill at the head of the Irwin River. This caused a good deal of excitement, but as the gold was in too minute a quantity to pay, this discovery, unfortunately, did more harm than good, for it brought a number of miners from the Eastern Colonies, who were so bitterly disappointed, that on returning home, they gave this place so bad a name that even at the present day it is difficult to persuade the people in those Colonies that there is any gold here at all.

The gold was found in the alluvium on the North side of the hill, where the spurs are capped with large deposits of red clay, sand, pipe-clay, and nodular ferruginous clay-stones, and judging from its highly waterworn appearance and the fact that the mineral veins of this locality are not auriferous, it has probably been derived from some old stream bed which passed across this country in a different course and at a higher level than the present rivers. Nothing certain can, however, be stated on this point until the district has been examined in detail and all the old water-courses mapped. The rocks here are mostly granitic, with diorite dykes and occasional quartz reefs of a highly crystalline character; but a few miles lower down the river, and also further to the Eastward, the country assumes a promising aspect for gold, the rocks being schistose and containing many nice looking quartz and ironstone lodes, though none have been proved to be auriferous.

At about the same period gold was found by Mr. Hassell, at Kendenup, in a quartz reef that contained much iron pyrites. A company was floated and machinery erected, but as the mine could not be made to pay it was abandoned, and this was due either to the manager not having followed the shoot of gold-bearing stone, or else, and more probably, to his not being able to extract the gold by the ordinary process, for nearly all stone containing so much pyrites requires special treatment, and, moreover, 5 tons sent to Victoria, where a speciality is made of such stone, yielded a very good return, consequently there is not the least doubt that gold does exist in this reef in payable quantities, and now that gold-saving processes have reached such a high state of perfection, it is to be hoped that another trial will be made. The rocks in this neighborhood are schistose, contain many quartz reefs and diorite dykes, both carrying large quantities of iron pyrites, most of which carries more or less gold.

The next specimens of gold found were in quartz, at Bindoon, and a company was immediately started which commenced work on a quartz reef containing a great deal of pyrites, by sinking two shafts, close together, on a reef at the top of a hill, and for which it is difficult to assign a reason, as this was not the reef in which the gold had been found, although it was afterwards proved to contain

small quantities. The general appearance of this locality is very promising, but it has not had a fair trial, as the reefs near to which the gold was found have never been prospected. The rocks are slate and schistose, with quartz reefs and diorite dykes, both containing large quantities of pyrites which ought to be tested for gold.

The gullies have not yet been prospected for alluvial gold, but so many rich specimens have from time to time been picked up here, it is natural to infer that the stream beds would pay for working.

Then, in spite of the fact that colors of gold had been found nearly all over the Colony, all idea of gold mining was, for some years, abandoned, until in 1885, when the late Mr. Hardman published his report on the Kimberley district, stating that he had obtained good prospects, and marking on his map certain tracts of country, which, from their great similarity to the Victorian gold-bearing country, he believed would prove auriferous. His prognostications proved to be correct, and some rich patches of alluvial gold were struck, which caused a rush of miners from the other Colonies, but as these patches, though rich, were of no great extent, and all in shallow ground, they were soon worked out, and many unfortunate men who had come all the way from Victoria, and made the long journey under a tropical sun from Wyndham or Derby to the fields, had to return poorer than they came, and thus another blow was given to the gold mining industry of this Colony.

These alluvial diggings, however, led to the discovery of some very rich reefs which bid fair to become a source of permanent employment in the district, and to pay those who have invested in them well. But, as in all cases where fields are far away from settled districts, we find two bogus mines for every genuine one, for somehow the former always seem to afford a much greater attraction to speculators.

Some of the lodes in this district are very remarkable, gold having been found in serpentine, in galena, and in calcite, though most frequently it occurs in a bluish colored quartz which is almost more of a quartzite in structure. The rocks are slates and schists of various kinds, with numerous reefs running a little to the East of North, composed of a yellowish grey or blue quartz, very cellular and vuggy, containing quantities of black and other oxides of iron, with pseudomorphs and crystals of iron pyrites.

At the end of 1887 gold was found by Mr. Anstey on the Yilgarn Hills, about 200 miles East of Perth, which led to that region being largely prospected, and to the discovery of a belt of country, extending for about eighty miles in a Southerly direction, rich in gold-bearing quartz reefs. Many companies are now at work in the different divisions of this field; namely, Golden Valley in the North, Southern Cross next, and Parker's Find to the South. The great difficulty at present to successful working is the scarcity of water. The rocks on this line of country are more or less indurated slates and schists, with here and there dykes of granite and other intrusive rocks. The reefs are, as a rule, large, and extend to a great length on the surface, but they are not well defined, and seldom have walls on both sides, one side generally splitting up into a large number of leaders, most of which are rich in gold. The stone itself is solid and of a quartzite nature; it contains a little carbonate of iron, both iron and copper pyrites, manganese, and chlorite, but not in sufficient quantities to interfere with the extraction of the gold. The stone, as a rule, is very rich, often containing as much as six ounces of gold to the ton, and the trial crushings that have been made prove that there is, at any rate, in one or two claims, a great mass of stone carrying about two ounces to the ton.

Gold is also found in this field in a great dyke-like mass of a greenish color—probably a decomposed serpentine.

Some rich deposits of alluvial gold have also been found, but, owing to the scarcity of water, little of the ground has as yet been tested.

There cannot be the slightest doubt that this field presents one of the finest surface indications yet met in Australia. Unfortunately at the present time it is almost at a standstill for want of capital to develop it, a difficulty that will be removed as soon as a railway is constructed to the field, for then many persons from the other Colonies would visit it, who are now deterred by the two hundred miles of bush travelling.

Gold has also been found in a small reef in the Wongan Hill, but not in sufficient quantity to pay.

In 1888 some very rich reefs were found to the Eastward of Roebourne Bay, and many of them were opened up, but, owing to the discovery of alluvial diggings in the neighborhood, only one or two are now being tested and these are proving to be of great value. The stone is a milky quartz with occasionally a bluish tinge, containing a large quantity of antimony associated with the gold. The reefs run East and West, and are the only known metalliferous lodes in the Colony running in this direction. The rocks are slates, often calcareous, with hard ridges of banded quartzite and large dyke masses of amygdaloid standing up out of the plain. There are also some very rich deposits of alluvial gold, extending over three hundred miles of country, and following the coast to the East and West. Up to the present most of the finds have been in shallow ground, but now richer deposits of gold are being found in the deeper alluvial deposits, and these are often associated with cementing deposits, similar to those occurring in the other colonies.

Judging from the large quantities of gold already sent away from this district it must be a very rich gold-bearing tract of country, and when the alluvial gold ceases to be the all-absorbing attraction, the reefs will be sure to receive attention.

Gold has also been found at Mulga Mulga to the North of Austin's Lake, but is not being worked at present, owing to the want of money for that purpose. It also occurs on the Greenough, not far from Yewin Station, and, lately, rich discoveries have been reported on the Ashburton, while all along the face of the Darling Range there are large reefs full of pyrites, most of which carry more or less gold, and some are very rich.

LEAD.—The first discovery of lead in this Colony was made in the Victoria district in 1840, or shortly after that date, and several very rich lodes between Geraldton and the Murchison were worked by English Companies.

The ores in these lodes consist chiefly of galena (sulphide of lead) and cerussite (carbonate of lead), associated with quartz, calcite, barytes, and blend (sulphide of zinc). The galena occurs massive and crystalline; as a rule it contains very little silver, but when it does it is generally granular in structure. In the mines in which cerussite occurs a great deal of trouble has been experienced through the workmen suffering from lead poisoning, so much so that work often had to be stopped.

The lodes are most frequently of great size, containing huge masses of galena almost free from gangue, and all of these that were accessible have been worked out, for, when the price of lead fell, the companies found that it did not pay to work the poorer parts, so they simply picked out the eyes and abandoned the mines.

Owing to this and to the facts that the old workings are now full of water, that they are perfectly unsafe, as it is so long since they were deserted, and that there is a very low percentage of silver in the ore, it is most unlikely that these mines will ever be re-opened, unless lead should increase very much in value; but as there are still many lodes that have not been touched, and others that have been very little worked, there is still a hope that the industry of lead mining

may be revived in this district. I trust that there may be then some supervision exercised in order to prevent the system of picking out the eyes of the lodes.

The lodes usually have a ferruginous cap; they are well defined and can with comparative ease be traced for a considerable distance along the surface, running about 20° to 25° East of North.

Several small but rich lodes of galena have been found in the Darling Range to the South of Perth, but, like those at Northampton, containing very little silver.

To the South-East of Roebourne there are some very rich lodes of galena, but these also are too small to pay for working.

In the Kimberley district galena associated with gold occurs, but only in small quantities. The gold is in a free state, and in the rich specimens is plainly visible to the naked eye.

COPPER.—The earliest discovery of copper occurred in the Northampton district, and many mines were worked with much profit until the great fall that took place in the value of this metal. The ore near the surface consists of malachite and azurite (green and blue carbonates of copper), but in depth it is invariably copper pyrites (sulphide of iron and copper), the "yellow ore" of the miners. The lodes run in the same direction as the lead, and in fact the latter often changes into copper in depth.

These lodes have been worked in much the same manner as the lead, and similarly there are many fine lodes, as yet unworked, and these would pay well to mine at the present time.

A little to the South of the Irwin River there are several rich lodes of carbonate of copper, which have not yet been worked, as the expense of cartage was too great; but now that copper is higher in price it is to be hoped that mines will be started in them, especially as they are close to the projected line of railway from Perth to Geraldton.

To the East of Roebourne there is one of the largest and richest copper lodes in the Colony, but there is not much chance of its being worked while so much gold is being found in that neighborhood; and, to the South of that town, there are also several copper lodes that were worked some years ago. In one of these the copper occurs as a brown ore; it is a mixture of carbonate and oxide of copper with oxide of iron, and gold is often visible in it.

Copper also occurs in the Wongan Hills, the Darling Range, the Glenelg Range, as well as in several other places.

TIN.—In the latter part of 1888 Mr. Stinton found some stream tin near Bridgetown, on the Blackwood River, which led to the discovery of very rich deposits, extending over an area of about a hundred square miles, but no lodes have been found up to the present, although they cannot be far distant, as some of the samples are very little worn, and so cannot have travelled far. The tinfields, if properly worked, will produce much wealth, but at present very little is being done, owing to the fact that the land is all taken up in large areas by companies that have been floated without sufficient capital to develop them.

The lodes will probably prove to be small granitic veins, which may occur as a net-work in the decomposed schistose rocks, with the cassiterite (tin-stone, oxide of tin) running throughout them.

Stream tin has also been found on the goldfields at Roebourne, but has not as yet been worked.

IRON.—This is essentially an iron country, for one cannot travel a mile in the parts where the older rocks appear at the surface, without encountering a lode.

It occurs in many forms, but the chief are magnetite and hematite (black and red oxides) which occur in immense lodes and would be of enormous value

if cheap labor were abundant. There is enough to supply the whole world, should the present sources be worked out.

From the large quantity of iron in this Colony it is almost impossible to work with any degree of accuracy with a magnetic compass.

ANTIMONY.—There are some very good lodes of stibnite (sulphide of antimony) in the Roebourne district, and their value in most cases is greatly increased by the quantity of gold they contain. They have not been worked yet, having often been put down as small lead lodes.

ZINC.—Blende occurs in the Geraldton district, associated with galena, but not in sufficient quantity to be worth working. Lately a large lode has been found a little to the South of Perth, and the samples sent in are very pure.

MANGANESE.—Manganese has been found in many places in the Colony, and some of the lodes are very good both in size and quality, but none have been worked.

MICA.—Very good mica has been found at Bindoon and also on the Blackwood River, but though of considerable size and splitting well, the specimens were too much iron-stained to have any market value formerly; but, now that a use has been found for discolored mica, it will pay very well for working and it is certain to be far less stained, if not quite clear, when quarried below the depth to which it has been weathered.

ASBESTUS.—Poor specimens of asbestus have been found in several localities, but nothing good enough to be marketable.

KAOLIN (*China-clay and Pipe-clay*).—Throughout the Darling Range, and in most of the granitic country, large and very pure deposits of kaolin occur, many of which are pure enough to be used as whitewash. These deposits will be of great value for china making, when the population increases.

COAL.—There are some seams of inferior coal on the Irwin River, and though the seams are from three to six feet in thickness, and the coal is of true Carboniferous age, yet none have at present proved to have a marketable value. This coal would be very useful for many purposes in a populous country, but here, where wood is so abundant and always close at hand, there is no demand for any, except a first class steam coal.

The carboniferous formation certainly extends for three hundred miles to the North of the Irwin, and probably all the way to Kimberley, so that there is a very large district yet untested in which superior coal seams may be found.

Coal has recently been found at Wyndham, but though the sample sent down was of very fair quality, the size and extent of the seams have not yet been tested. Should it prove to be a good steam coal it will be of great value, as it occurs close to one of the best harbors of the Colony.

LIGNITE.—On the Collie River, near Bunbury, there are several seams of a very superior lignite, probably of Mesozoic age. The following are the results of three assays by Mr. Bernard H. Woodward; No. 1 being of the first specimen obtained, which was in the bed of the river itself; No. 2 from a depth of 17 ft. close by, and No. 3 from a similar depth in a shaft five miles distant.

				1			2			3
				—			—			—
Volatile	...	{	Water	...	...	15.20	...	10.87	...	11.70
			Gases, &c.	...	32.46	...	31.47	...	21.83	
			Sulphur	...	2.23	...	2.23	...	2.99	
Coke	...	{	Fixed Carbon	...	45.03	...	52.87	...	54.17	
			Ash	...	5.08	...	2.56	...	9.31	
				100.00			100.00			100.00

The ash of Nos. 1 and 2 is very pale yellowish white, and of No. 3, red.

None of the lignites cake, nor do some coals, and, unfortunately, both the Irwin and Wyndham are non-caking, and so lose much of their value, through not being available for gas making.

There are several seams of lignite of a highly lustrous character on the Fly Brook, near Augusta at the South-West corner of the Colony. It contains so much water and is so friable that it will not stand much handling, for in fact it breaks up in drying, and consequently is of little value.

There is another deposit of lignite near the Vasse, but, up to the present time, the specimens that have been raised are of a very poor quality.

Brown coals occur all along the South coast, and there are some large deposits near Albany, and on the Fitzgerald River, which have been tested, but proved of too poor a quality to have any practical application.

GRAPHITE.—Graphite was found in some ferruginous lodes in the Champion Bay district and was tested some years ago, but proved to contain too much iron to be of any commercial value.

Some fair deposits also occur between the Warren and the Blackwood Rivers, in the South-West, where several claims have been taken up, though as yet very little work has been done.

Some years ago a deposit of graphite was worked at Kendenup, and the samples sent away were stated to be of very fair quality, but, owing to the distance from a port, the mine was abandoned. Now that the railway passes so close another attempt should be made to utilise this deposit, and would most likely meet with success.

Sufficient evidence has now been brought forward to show that this is decidedly a mineral country, and when we take into consideration the vast size of the Colony and the small number of inhabitants, and consequently the small amount of prospecting that can possibly have been done up to the present, there cannot be any doubt but that many more, and, perhaps, far richer deposits of valuable minerals, may be found; but as we have already discovered more than we can at present use, what is now needed is the incoming of enterprising people with money from other parts of the world to assist in developing this known mineral wealth. It is often asked by persons in other places, why, if we have such wonderfully rich deposits, we do not work them all ourselves instead of offering them to others, and to this the answer is that as there are not sufficient people here with money to work more than one or two mines efficiently, while at the present time they are trying to develop a hundred, and as a natural consequence failures are occurring on every side.

SUMMARY OF WORK DONE IN 1888.

In November, 1887, I was appointed, for a period of five years, Government Geologist to Western Australia, receiving at the same time instructions from the Secretary of State to the Colonies to proceed at once to this Colony. I therefore left London on the 2nd December, and arrived at Albany on the 6th January, where, being unable to obtain a seat on the mail, I had to remain a week for the boat.

On arriving in Perth I reported myself to His Excellency the Governor, and received instructions to proceed to Yilgarn to report upon the gold discoveries of Messrs. Anstey and Von Bibra. Immediately on my return I was instructed to go back again, in order to examine the find of Mr. Colreavy, at Golden Valley. I had met him on the road, and, had he then communicated his discovery, I should have been saved this second journey.

My next trip was to the Wongan Hills, to see the gold reef found by Mr. Paine, at Little Wongan. After this I proceeded North to Roebourne, to examine the Mallina and Peeawah reefs, and on my return journey received instructions by telegraph to look into some new mineral discoveries in the neighborhood of Geraldton, which I imagined to refer to the Mulga Mulga or Berin Fields, and so proceeded there, but on returning to Geraldton found that they referred to some new copper lodes in the Northampton District, so I visited them and also the Geraldine District, and returned to Perth overland so as to be able to see the coal seams on the Irwin River.

I then proposed that a certain amount of work should be done each year in a systematic manner, which suggestion meeting with approval, I proceeded to Gingin, Bindoon, and Berkshire Valley. I then took an Easterly direction to see if the line of gold reef found at Yilgarn and Mulga Mulga was continuous, and found this to be the case, by striking it at Mount Kenneth. I then returned by Peterwangy, the Irwin Coal Field, Yandenooka, Dongara, and Geraldton, where I took boat to Perth in the beginning of December. The remainder of the year I employed in arranging my office, and compiling a map from the Survey Records, in which I received much assistance from the Officers of the Crown Lands Department, and from Mr. Ridley, and I take this opportunity of publicly thanking them.

During this year, 1888, I travelled about 8,100 miles on service, and roughly mapped 67,500 square miles of country.

The following are the Reports which I furnished to His Excellency the Governor after each trip, and which have mostly appeared in the newspapers.

FIRST REPORT.

Issued in February, 1888.

COUNTRY PASSED OVER AND INSPECTED FROM FREMANTLE TO NEWCASTLE, AND EASTWARD TO YILGARN.

There are large drifting sand-dunes along the coast, near Fremantle, which are a great source of trouble to the town, for whenever strong winds blow from certain quarters, for any length of time, roads are rendered impassable, and gardens, walls, and even houses are occasionally buried.

Below these occurs a series of false bedded calcareous sandstone of Tertiary age, which further inland rises into a low coast range. The upper beds of this formation contain in places fossil shells of forms that are nearly all still existent, while those of the lower beds and nearer to Perth are mostly of Eocene age. This formation varies in composition from coralline and shelly beds to sand-rock. No complete collection of these fossils has as yet been made.

The Swan valley is bounded by high cliffs or hills of sandstone, almost as far as Perth, when it spreads out into a wide undulating plain extending up to the Darling Range. The clay beds which here crop out are probably of much greater age, though at present we have no certain information, as no deep wells have been sunk and no natural sections are visible. There are extensive estuarine deposits under Perth itself, which indicate either that the Swan, in former times, was much wider and deeper here than at present, or that its course has changed, and that it discharged itself into the sea to the North of its present mouth.

On approaching the foot of the hills one meets with large deposits of clay, sand, and clay ironstone, but these entirely disappear on ascending the steep slope of the range, where granitic and gneissic rocks, intersected by numerous dykes of diorite, make their appearance.

This face of the hills was probably the old coast line, and if the deposits of clays and sand were removed we should most likely find the old cliffs against which the Tertiary sea used to wash. Continuing Eastward the ground rises rapidly; the rocks are almost entirely covered by large deposits of red clay and nodular ferruginous clay-stones (locally called gravel), and these, where deep wells have been sunk, have been shown to overlies beds of pipe-clay, evidently derived from the decomposition of the feldspar of the granite. In constructing the railway a very thick deposit of pipe-clay was encountered in a gorge which drains a tract of country to the East, and caused a great deal of trouble, for the water kept it in so boggy a condition that it swallowed up ballast as fast as it could be put on, and sheet-piling had to be adopted to effect a crossing. It is difficult to account for these nodular clay-stone deposits, but in all probability they owe their origin to the bush fires which are common in this upland forest country. These fires burn the clay, whilst the upturning effect of the roots of the trees and the drip from them in rainy weather cause the rounded appearance. When large quantities of iron occur they frequently form a sort of conglomerate cake on the surface, but in most cases they form thin beds at the surface intermixed with more or less clay or sand, which, on the lands being cleared and cultivated, rapidly decompose, forming clays. Similar country, *i.e.*, granitoid and gneissic rocks with superimposed clays and clay-stone, extends as far as Clackline, after which it varies a good deal in character, the rocks becoming more schistose, though in places large masses of gneiss still occur, while diorite dykes are more numerous; there are also veins of diorite containing actinolite and plenty of quartz reefs, which, up to this point, are of rare occurrence, and those of a very barren and crystalline character. When the highest ridges, consisting of hard gneissic rock, are passed, the valley of the Swan, or, as it is here called, the Avon, is re-entered, and almost for the first time mica schists are seen. These are comparatively soft. The country here assumes a more decidedly mineral character.

Country of the same kind prevails for some distance to the Eastward of Newcastle, rising gradually till an elevation of 1,000 feet is attained, when the sand plains begin. A few small patches are crossed before reaching Goomalling, but to the Westward of that place, for about sixty miles, they cover almost the whole country, with the exception of an outcrop here and there of granite, and an occasional patch of light loamy land. These sand plains evidently belong to the great desert sandstone formation so largely developed in central Australia. The sand is seldom loose, except where cut up by the traffic, and might almost be called a sandstone, the grains being held together sometimes by clay, often in considerable proportion, at other times by iron, or by both together.

The granite bosses occurring in this line of country appear to be mostly intrusive, for in rare instances do they show any signs of former stratification. They are very frequently traversed by dykes of granite having an entirely different character to that of the main mass.

The country changes entirely at Mugakine, where porphyritic and gneissic rocks, containing many quartz reefs, make their appearance. This was the first place in the Eastern District in which gold was reported to have been found, but although it has been well prospected since, none unfortunately has been obtained. Shortly beyond this the first alluvial flat is crossed; it is that which drains the Cowcowing Lakes, but is of no great extent, being confined at this point between two low ranges of hills. At Yarraging and on to Mangowine, quartzite and schistose rocks out-crop, in which many quartz reefs occur. From one of these, a few miles South of this place, a quantity of stone was sent away to be crushed, but only yielding a pennyweight or two to the ton, will not pay to work.

The country between this and Yilgarn is mostly open, with large alluvial sandy plains, though here and there huge masses of intrusive granite stand out in great bold hills, but no other rock breaks the plains.

YILGARN HILLS.—The Yilgarn Hills are a low range of hills about 250 miles East of Perth, on the Western side of a series of salt lakes, of which Lake Deborah is the Southernmost.

They are from two to three miles in width from East to West, whilst the general direction of the range is North and South. The Western face is somewhat steeper than the Eastern, which gradually descends towards the lakes, from which it is separated by a plain, from four to six miles in width, of red clay strewn with ironstone and quartz.

The rocks are mica schist, mica slate, and flaggy quartzites, with many diorite and quartz veins: their general strike is North and South, with an Easterly dip. They have been tilted up from the West by a large mass of intrusive granite, which forms a rough Western face to the hills in the Northern part, while in the Southern it is only seen appearing above the surface of the plain in large rounded masses. The quartz reefs follow the strike of the rocks, but vary greatly in character, those of the white quartz being, as a rule, not in such large masses nor so well defined as the more ferruginous ones.

ANSTEY'S REEF.—On this claim there is a series of small veins of variable thickness, which pinch out or become so small that one vein cannot be traced far in any direction at the surface; whilst underground, as seen in the shaft, the vein dips first East, getting very small, then turning over suddenly to the West it makes a large body of stone, but without any defined walls, and in character more of a quartzite than a true quartz; it is of a reddish color at the surface from the decomposition of the iron pyrites, and in one place is so friable that it can be crushed up to sand between the fingers. This reef then takes another sudden turn to the surface where it makes its appearance about 10 or 15 feet to the W. of the shaft, and was in all probability connected by another bend above the present surface, which has since been washed away, with another reef a little further to the West.

The rocks between these veins are kaolinized mica slates, which in some parts have been so highly altered as to form nearly pure kaolin.

It is stated that gold specimens were taken from the surface where the shaft now is, and all along the cap for a distance of about 20ft. South of it, but as no gold has been obtained since the shaft had been sunk, the claim has been abandoned. This, like many veins in broken country, where the gold is patchy, has proved to be very unsatisfactory to work, for when one rich patch is worked out there is no telling how far one may have to go before finding another.

BIBRA'S LINE OF REEF.—This is a large reef, a little to the East of Anstey's, of ferruginous and jaspery quartz, with bands of hematite; it forms a series of hills or blows, and is easily traced for about ten miles in a Northerly direction.

But this, although supposed at first to be very rich, unfortunately did not prove so on crushing, and has therefore been given up for the present.

BUSH'S LINE OF REEF.—This is two or three miles South of Anstey's, and is a white quartz vein with dark bands of iron and masses of gossany hematite, evidently resulting from the decomposition of iron pyrites. It is not bad looking stone, but I was unable to obtain any gold from the specimens I crushed.

About 18 miles North of Anstey's the country changes a little in character, the Western side of the range being granite, whilst the Eastern is slate and shales of a more calcareous nature, intersected by many diorite dykes. In the granite the veins are white quartz containing some pyrites, but not well defined; there are also large yellow jaspery reefs, and large blue and red banded quartz veins, with some hematite, though not of a very promising appearance; while in the slate country to the East they are rather lenticular masses of white quartz with ironstone, some of which can be traced for a good distance, but most for only a few feet; these veins have a far more promising appearance than those in the granite.

GOLDEN VALLEY.—Golden Valley is situated about 12 miles South of Anstey's reef, in a continuation of what is really the same range of hills, although a break occurs where the lake passes to the East through the range. The rocks and general character of the country are almost identical; granite rocks protruding through the plain to the West; then low undulating country of decomposed mica schists, with diorite dykes and quartz reefs; while further East are mica slates, quartzites, and hornblendic rocks, with large ferruginous reefs and ironstone lodes.

In the valley itself there are, as far as I can make out, two fairly defined reefs; one, on Mr. Colreavy's claim on the Eastern side of the valley, has been opened in several places, but as the holes have either been filled in again or the reef has been torn up and broken into small pieces by the numerous prospectors who have visited this claim, it is quite impossible to say what body of stone there is, in what direction it dips, or what is the general formation of the reef. As all the surface stone had been well looked over, it took some time before I could see even a color, and indeed it was not till Mr. Colreavy opened a small place on the reef that I could find anything worth calling a specimen. The gold is very fine but nuggety, and is generally found in the iron-stained portions of the reef or in little cavities with oxide of iron, resulting from the decomposition of the mundic.

The reef is decidedly worth opening up, but how it will behave in depth it is quite impossible to say till more work has been done, but I think there are good grounds for hope from the fine character of the gold, scattered as it is throughout the stone.

On the Western side of the valley are two claims, the "Edith" and the "Marion," probably both on the same line of reef, but this is not at all certain, as no work has been done on them yet. I was able to obtain pretty good specimens from each, at the places where the prospectors had been grubbing.

The stone is rather different in character from Mr. Colreavy's, being less iron-stained, but the gold seems, as in the former, to have been associated with pyrites. These claims are also worth testing, and should there prove to be one reef passing through both, there will be a great probability of finding gold between them.

I believe gold is reported to have been found by Messrs. Barratt & Saunders four miles to the North, and by Mr. Crossland about two miles South of the Golden Valley, but as a quarter of a mile square was rather a large area to look over for a few specks of gold in the limited time at my disposal, I was not successful in finding any. Colors are reported to have been found, on crushing, in many other places, but I do not think that anything rich has been discovered up to the present. Taken as a whole, the country is decidedly auriferous, but there will have to be a good deal of hard work and money expended on it before any idea can be formed as to whether it will pay. Water at present is the great obstacle in the

way of prospecting, but the boring machine will soon test the country, and I have great hopes of their finding fresh water in the flat a little to the South-East of Golden Valley, which is divided from the salt flats by some hard ridges of rock.

Prospectors who intend to test their claims would also do well to construct dams before the rains; but these will have to be puddled when the first shower falls, as the sandy loam of the gullies will not hold water unless it be puddled, when it becomes quite impervious.

The country to the East and South, as far as I can judge from a distance, appears to be similar in character, and I hope as soon as the rain sets in to be able to take a long trip in the direction of the Hampton Plains.

As a whole this country is very promising, and I hope that it will be thoroughly prospected as soon as there is rain. Rich alluvial deposits will probably be found both in the Golden Valley itself and in the South.

I returned by the York road, which passes through very similar country, but as it follows for the most part the low drainage line, it is, from a geological point of view, very uninteresting; moreover, the scrub and thickets are so dense that it is a very rare thing to get a glimpse of the surrounding country, and, with the exception of Mt. Stirling, very few hills of any size are seen. There is, however, one point on the road of some interest, where some nice looking quartz reefs cross the schistose rocks near Nulligan.

All the rocks crossed on this line have a N. and S. strike, but a variable dip sometimes E. and sometimes W., for as they are always inclined at a very high angle, little change is required to turn the dip from one direction to the other.

SECOND REPORT.

Issued in May, 1888.

YORK TO NORTHAM, NEWCASTLE, NEW NORCIA, AND THE WONGAN HILLS.

To the North of York the road follows for some distance the valley of the Avon, passing over hard crystalline rocks, *e.g.*, hornblende schist, gneiss, and granite, with numerous dykes and quartz veins; some of the latter are iron-stained and of a granular character, much resembling the auriferous stone of some parts of the Colony.

On leaving the river the road crosses a small rise, capped with clay and clay ironstone, then descends into the valley of the Mortlock, where rocks similar to those nearer York are met.

Between Northam and Newcastle the river flows North-West through a rocky gorge, which in all probability follows a fault occurring across the strike of the series of schistose and gneissic rocks.

The road to the North from Newcastle, for some way follows the Toodyay Brook, then turning North-West crosses a series of very rough schistose hills, after which it passes over high ground covered with sand and clay ironstone for about 30 miles, when, near the junction of the Perth road, the country begins to fall toward the East Moore River, and the crystalline rocks re-appear, with a series of quartz reefs of a very promising character. Similar country extends for about fifteen miles. The road then follows the Victoria Plain, the alluvial deposit of the East Moore River, which has high hills of crystalline rocks on each side. Continuing Eastward, towards the Wongan hills, for a few miles there are ranges

often capped with ironstone gravel, and the remainder of the distance lies over sand plains which here extend much further to the Westward than they do further South.

WONGAN HILLS.—These hills are situated about 60 miles N.N.E. of Newcastle. They appear from the Westward as two or three isolated peaks, but on approach they are found to be the highest points and to form the abrupt termination of a range, which runs from this point in a N.E. direction. They are flat-topped hills, presenting a bold escarpment to the S.W. of about 300ft. above the surrounding clay flats: this face is probably caused by a line of fault, which would also account for the springs near their base.

The rocks are mostly metamorphic and crystalline, hornblende schists with veins of radiated actinolite, small beds of chloritic and micaceous schists and small quartz veins. These rocks strike N.E. and S.W., following the direction of the range, dipping at an angle of 60° to the N.W., and making their appearance again in a small hill to the N. called the Little Wongan. Granite rocks form the low ridges to the N. and S.; they are often almost covered by sand or ironstone conglomerate.

The highest peaks of the range are capped by a ferruginous conglomerate, nodular clay ironstone gravels, intermixed with sand or clay, clays and ferruginous sandstones horizontally bedded. These beds also cap the low granite ridge, but occupy many different elevations owing to the upheaval of the Wongan to the N.E. of the fault.

The recent deposits are sand, clay, and loam. Of these the sand greatly predominates, forming large plains to the W. and N., occasionally interrupted by large salt flats and clay pans.

The loam forms patches of rich red soil (generally thickly timbered with gimlet wood).

There is very little to be seen of the Plutonic rocks at the surface; a few small diorite dykes occur in the range, and probably some of the granites at the low foot hill are intrusive.

Quartz in this district is quite a rarity, and what there is of it is of a yellow glassy appearance, containing either pyrites or brown hematite.

Gold has been discovered on Mr. Paine's claim, which is situated on the top of the Little Wongan, a small hill about 6 miles North of the range. The reef is about 18in. wide, between well defined walls, dipping at an angle of about 65° in a N.W. direction, its outcrop following the strike of the rocks N.E. and S.W. At present they are engaged in testing it in depth, and are down about 10ft., in very hard ground; they have not opened the reef along its outcrop sufficiently to determine what body of stone carries gold, but where they are sinking they have obtained very good specimens and prospects, both from the reef and the casing. This reef is worth opening up, but unless it proves very rich, or makes a larger body of stone for some distance along its course, it will not pay to work, as the reef itself is so small, and the country so hard.

A prospect has also been obtained from a small hill to the South of the latter, held by Messrs. Glyde and party. The reef runs in a N. and S. direction, dipping at an angle of about 25° W. The stone here is very similar to Mr. Paine's, but contains more hematite: the size of the reef as yet is unknown, as they have not yet sunk through it, and the workings are too much in their infancy for me to express an opinion. Very few of the other claims have any sign of a reef at all on them, but were taken up, in the hope, I imagine, of striking a reef in depth, and this idea I would strongly advise prospectors to give up till we know something more of the behaviour of reefs in this particular district.

From the nature of the rocks and the great scarcity of quartz in the part of the district I have seen, I do not see any prospect of its turning out a rich gold-field, but if prospectors intend to give it a trial, I would advise them to go prepared to make some flying trips to the N.E., as the ground all around the present discovery is already taken up, and nothing is left but clay or sand flats.

South of the Wongan Hill, for some miles, there are nothing but sand plains and salt lakes or swamps, but where the ground rises more towards the ranges clay ironstone, ferruginous sandstones and clay make their appearance, and here and there an outcrop of rock is exposed in some of the deep gullies. From Bulgate the road descends into the valley of the Toodyay Brook, where the same rocks are met with as were first passed over on leaving Newcastle.

THIRD REPORT.

Issued in July, 1888.

COSSACK, ROEBOURNE, MALLINA, PEEAWAH, CROYDON, THE PYRAMID, AND WOOD BROOK.

COSSACK.—The first thing that strikes one on landing at Cossack is the black appearance of the rocks and the black streaks down the faces of many of the cliffs, which, from the sea, look as though tar had been poured down them. These streaks were at first taken for coal, but as they would not burn were put down as of volcanic origin, and indeed this part of the country presents at first sight very much that appearance; however, on examination, they proved to be veins of black tourmaline in a compact hornblende rock, evidently intrusive, as it has no signs of bedding, and much resembles diorite in character. There are also veins of quartz and hornblende, the latter generally very green in color, intersecting these rocks. These rocks form the rough bold cliffs and headlands which separate the sea from the low salt swamps that lie between Cossack and Roebourne. The sea finds its way round the back of these rocks at spring tides, covering them with a layer of water which evaporates before the next high tides, leaving its burden of salt.

On the Roebourne side of this swamp some low rocky ridges of ferruginous quartz make their appearance through the alluvium of the plain, and in these gold is said to have been found some years ago. The stone looks very well, but so many more tempting things have been found in the district that no attention has been paid to them of late.

ROEBOURNE is situated eight miles inland from Cossack on the Western side of the Harding river. It is built round the base of a hill called Mt. Welcome, which forms the Eastern end of a small range following the coast in a South-Westerly direction. The rocks of this range are very similar in appearance to those of Cossack, but as they show signs of bedding must be of sedimentary origin. They contain many dykes. On the Eastern side of the large alluvial flat of the Harding, which is about eight miles wide, is Mount Hall. This small range is composed of hornblende schists with trap dykes, and lies in the fork of the Harding, which a little higher up has split into two branches, one, the Western, flowing through a gorge past Roebourne into the sea at Cossack, and the other, the East Harding, flowing through the large alluvial flat it has formed, and which joins the large alluvial plain which here stretches all along the coast up to the ranges, which in some places are thirty miles inland. The surface of this plain is often broken by low ridges of rock, and it is skirted along

the sea shore by mangrove swamps, though occasionally, as at Cossack, it is separated by low rough ranges. The road between this place and Fisher's lies across these plains, passing several low, rough, isolated hills of granite, quartz, or quartzite, and skirting the low rolling ranges to the landward.

Between Fisher's and Withnell's there are some low broken ranges of actinolite and hornblende schists, quartzite with diorite dykes and quartz veins containing a good deal of hornblende. To the South are seen some bold rugged ranges, the rocks of which appear from a distance to be either quite black or red; beyond which the country appears to be a table-land, the top of the ranges being perfectly horizontal, with here and there a detached flat-topped mass, only one forming a peak, which is known as King's Pyramid. A large alluvial flat extends from Withnell's almost to Balla Balla Creek, but judging from the large quantities of quartz at places, the rocks cannot be far beneath the surface. Gneissic rock was struck in making a roadside well, and rock appears in two or three small hills nearer the coast.

At Balla Balla Creek there are low rolling hills of clay-slate, with numerous quartz veins of a highly promising character, which, taken together, form the nearest approach of anything I have yet seen to the gold bearing country of the other colonies. In this creek there is a fine large lode of copper, easily traced by the gossany cap, which is often strained by the copper, and in some holes, scratched out by the kangaroos, the walls and roof are perfectly green. Fine specimens of native copper, green carbonates of copper, and ferruginous oxides are to be found in the bed of the stream. I should strongly advise the testing of some of the gossany parts for gold and silver.

From this point extensive ranges run to the South-West, while to the North and West are some bold hills and masses of rock, standing out of the plain to the height of 600 and 800 feet, formed of amygdaloid, the cavities of which are filled with agate, calcite, and other minerals, and traversed occasionally by felstone dykes. I consider the gullies around these hills should be prospected for precious stones, for there is every chance of their being found. These hills are smooth and bare, with hardly a sign of vegetation, and are so steep as to be quite difficult to climb.

MALLINA AND PEEAWAH.—Mallina, 70 miles East of Roebourne, and about 20 miles South of the sea, is situated on the large low alluvial plain which extends along this North-West coast between the low ranges to the South, and the sea to the North.

On the Mallina claim there are two outcrops of quartz; the first, a large, white, barren-looking reef, rising out of the alluvial plain, and forming a hill running East and West, almost the length of the claim. The second, a small reef on the South side of the hill, from 9in. to 2ft. in width, following the contour of the hill, and apparently dipping slightly towards the larger reef. Both contain a certain amount of antimony.

In this smaller reef gold was first discovered, and it proved so rich that it was decided to sink a shaft on the large reef, to cut the junction, as these intersections of auriferous reefs have generally proved of great richness. A shaft was therefore sunk 27ft. on the South side (footwall) by the cap of the large reef, but without success, as down to that point no stone was struck. A drive was therefore put in to the North on this level, to test the main reef, which here proved to be slightly over 10ft. wide and of so greatly improved a character that the work of testing it was carried on in a Westerly direction by a series of steepes or stopes. The reef not only improves in this direction, but carries gold in the solid stone, the richest stone being on the footwall, where I have seen some nice specimens. Four tons of stone are now on their way to Melbourne, but should the trial crushing from the main reef not prove so good as is expected, I would still advise the proprietors to continue their work, as they have every reason to hope from the

large quantity of stone, its improving character in depth, and the richness of the small reef which will probably join it, that this will eventually prove to be a very valuable property.

There are several other claims on this line of reef, and I hear that, since I left, gold has been found in the adjoining ones; but at present very little work in the way of testing has been done, as there has been a great deal of trouble in finding the reef, which is covered by some eight or ten feet of red clay, and further the prospectors were not certain of its true bearing.

Martin's line of reef runs parallel to the latter, but a few hundred yards to the North. Gold was first found by Mr. Martin about half a mile to the Eastward in a small outcrop of quartz, which appeared above the clay plains. On opening it up, the reef proved to be about ten feet wide, and dipping, as the other did, to the North, but differing from it, as the reef seems to comprise two veins joined together: the small one from eighteen inches to two feet wide on the hanging wall, being very rich in gold, whilst the larger mass of the stone is at present of a more hungry looking character, but as this has only been opened up to about ten feet, it is rather early to form an opinion. The reefs on this ground are very promising in character, as their walls are well defined and they can be traced for a considerable distance; although they appear to be cut out, or to be thrown on one side by a fault, as on a small hill on the direct line of the reef, about one mile to the Eastward, there is no sign of quartz, and the rocks are rather different in character from those near the reef.

About five miles to the East another find has been made by Messrs. Wells & Co. It consists of a small reef from two to three feet in width, dipping to the South. The stone in places shows gold freely but is very different from that at Mallina, and contains a great deal of antimony, so much so, in fact, that I should be inclined to call it an auriferous antimony lode. A shaft has been sunk passing through the reef near the surface, to a depth of 47 feet (water level), and I believe they will now drive to the reef, which is about 15 feet South of the shaft, and test it along its line of strike.

I do not think this reef can be worked by the ordinary gold extracting processes, as the presence of so much antimony will cause great loss of gold, but as that metal will probably be found to carry a good deal of gold, the ore will either have to be dressed and sent away, or smelted on the spot. Mines of similar character have been worked with great success in Victoria, and proved to be very rich in gold.

There is another claim in this reef that has also struck gold, but it was not being worked when I visited the field. There are also several claims round about, but nothing has yet been struck having the character of a true vein.

The rocks near these reefs, where visible, are clay-slates of a slightly calcareous structure: they are, however, generally covered with thin deposits of travertine limestone, so that, as a rule, nothing is seen beyond either a blow of quartz or a large quantity of the same mineral scattered over the surface of the plain.

A little to the Westward of Mallina there are two or three isolated rugged stony peaks, one of which is called Mount Spinifex. The rocks are chiefly banded quartzite with ferruginous quartz reefs; these latter are not of a promising character.

Some miles South of Mallina some long low ranges occur, principally of quartzites and clay-slates with quartz reefs and trap dykes, having very much the appearance of the South Australian copper country. Following these ranges round to the South, and after crossing a low saddle of clay-slate, we come upon a large alluvial flat surrounded almost entirely by hills. These flats occur on all

the rivers just behind the hills, which seem to indicate that a long period elapsed before they cut channels through the hills, during which the water, being dammed in, deposited its sediment in what must then have been extensive swamps or shallow lakes. All along the edge of this flat and the hills to Croydon, on the Sherlock River, there are numerous quartz reefs, which have very much the appearance of gold bearing rock.

From Croydon the road runs in a Westerly direction across these alluvial plains to the crossing on the Sherlock, which, between the station and this point, makes a great bend to the South-West, following close under a rugged rocky range of amygdaloid rocks through a gorge along which the road also passes after it has crossed the river. The rocks here have all the appearance of a "tip" heap, except that the masses often weigh several tons; they are almost destitute of vegetation, and being nearly black in color the passage of this gorge on a hot afternoon is anything but agreeable.

It leads to another alluvial flat, several miles wide, reaching to Pyramid Station, so called after the hill before mentioned as seen from Fisher's. This hill is a few miles to the South, and is, as I had imagined, capped with a horizontally bedded sandstone, being a detached portion of the large formation extending into the interior as a great table-land. I, unfortunately, had not time on this trip to visit the latter.

From this point to Wood Brook the road follows a small flat, to the South of which are still seen the amygdaloid hills. These, however, on approaching the station, are replaced by a quartzite conglomerate, containing in places a good deal of iron pyrites. Between this and Roebourne the rocks again change, the crystalline schists being largely developed, and in the ranges large masses of trap stand out, looking quite black in contrast to the pale grey color of the schists, while here and there a wide alluvial flat occurs.

A few miles South of Roebourne some copper mines were worked a few years ago. They are situated at the base of some low slate and quartzite hills on the edge of a large flat formed by one of the branches of the Harding River. These lodes are chiefly ferruginous oxides of copper. In one shaft gold is often visible. There are two sets of lodes, one running more or less North and South and dipping East, while the other runs East and West and dips North.

A good deal of work was formerly done here, but has been discontinued—I suppose owing to the low price of copper—but as the ore I saw at the surface was so good, and the lodes are so large and so near a port that they could be worked cheaply, that now copper is realising a higher price, they ought certainly to be re-opened. In any case the one containing gold should be worked, as that metal can be separated from copper so much more economically than it could twenty years ago.

Galena has also been found in this district and proved to be very rich in silver, but for some reason has never been worked. I did not see the mine, as it was not in the direction I had to travel.

Taken as a whole, this is decidedly a mineral-bearing country; in fact, the most promising I have yet seen in the Colony. It should be thoroughly prospected, for as there are such large tracts of alluvium near to reefs that have been proved to be rich in gold, there is every prospect of rich alluvial deposits of that metal being found.

FOURTH REPORT.

Issued in September, 1888.

THE MURCHISON, GREENOUGH, IRWIN, CHAMPION BAY, AND NORTHAMPTON DISTRICTS.

On July 3rd I left Geraldton on a trip to the North-East to examine a newly reported discovery of gold at Mulga Mulga or Berin, which is situated about 250 miles from the coast, between Austin's Lake and the Weld Range.

Immediately after crossing the sand dunes which follow the coast, there is a large alluvial flat, the Northern extremity of the back flats of Greenough, and probably in former times the bed of the river of that name, which would then have discharged its waters into Champion Bay, somewhere about the mouth of the present Chapman River. To the Eastward of this flat, the land rises into a series of flat-topped hills of Secondary age, of a decidedly unprepossessing appearance at first sight, but the bad impression is soon dispelled on passing through the valleys with rich soil and springs which break out here and there from the sandstone beds which form the capping of the ranges.

The table-land on the top of these hills is a scrubby, sandy plain, about 800 feet above the sea level, and extends inland for about 70 miles from the coast, only varied in patches by gum thickets, where the sandstone has been denuded, exposing the underlying clay beds (of Carboniferous age?), and by the deep gorge which is cut across it by the Greenough River, in the bed of which a fine series of sections of Mesozoic and Carboniferous rocks are exposed. At Mullewah the country entirely changes from sand plain to crystalline rocks, with numerous quartz reefs, which run nearly North and South, being the same line of beds that form Peterwangy Hill and the Tallering Range. There has been some prospecting done about here, but at present without success.

Between Mullewah and Bunbenoo the rocks met with are mica schists, quartzites, sandstones, gneiss, granite, and hornblende rocks, with numerous quartz reefs and diorite dykes, capped in many places by newer beds of ferruginous clay-stone and sandstone.

There are several springs along this belt of country, the waters of which contain large quantities of lime, as large deposits of travertine and calcareous conglomerates are met with round them; these latter deposits are a sure indication of water. One of these springs called Karla contains a good deal of mineral matter and is not fit to drink, but I was unable to test it, as it is impossible to carry samples of water far on a pack horse with safety.

The country on to Gabbeon is mostly metamorphic with outcrops of granite and belts of schistose rocks, with quartz reefs, covered here and there by sandy flats. To the North-East for 100 miles the country is mostly of one description, i.e. large clay flats with bold granite hills and low ridges of metamorphic and crystalline rocks, often capped with nodular clay-stones and ferruginous sandstones.

Gold has been discovered in a reef in one of these low ridges, between Austin's Lake and the Weld Range. The reef appears to be what miners call a saddle reef, that is it dips both ways; one leg dipping to the East, and one to the West. The stone is a saccharoid quartz, containing a little pyrites and sulphide of antimony, and shows gold freely in the Western leg a little to the South of, or lower down the hill than the junction. The reef runs a little to the East of North, dipping to the West where the gold was found. It joins another reef a little higher up the hill, which I take to be the other leg. The width is yet

uncertain, but I should judge it to be between two and three feet; it is of a very promising character, and in the hands of Messrs. Birk & Co. will, I believe, be thoroughly tested.

The great feature of this part of the country is the number of quartz reefs which are seen rising through the low hills, and standing up as ridges out of the flats, and miles of the country are covered with their *débris*.

There are three or four different classes of reefs, probably of different ages, but which series carries gold cannot yet be determined.

The country to the South of Warra Warra has also a very promising appearance for gold; there are small beds of slate between hornblende schists and quartzites with quartz reefs and iron lodes. To the North of this again the bold granite hills burst through the surface, with sand and clay plains between them in places. Similar country extends as far as the Sanford River, where the fine alluvial plains of the Murchison are sometimes broken by low ridges of metamorphic rock generally capped by sandstone. Between Murgoo and Yewin the water parting of the Murchison and Greenough has to be crossed: it consists of a high belt of country running in an East and West direction, the main portion is granite flanked on either side by metamorphic rocks, the whole often being covered by the newer sandstones. From Yewin to Bunbenoo you cross a series of low hills of sand or light loam, with the older rocks again making their appearance about three miles North of Bunbenoo. This district is full of patches that should be prospected, first the line between Peterwangy and Talling, about half way between Pindar and Bunbenoo, the country about Yilgady which is South of Warra Warra, and the country, where gold has been found to the North of Austin's Lake, which is of great extent, and I should judge from its position to be the Northern extension of the Golden Valley country, as the stone and the rocks are very similar in character. It lies, as the Southern discovery does, to the Eastward of a line of granite country, which is also about the same width, but as the Murchison district crosses it diagonally, it appears to be of much greater extent. This question I hope to be able to settle in my next Report after visiting the country between these two points.

There is no reason why this country should not be thoroughly tested as water can be obtained almost everywhere without any trouble, which will give it a great advantage should it prove to be rich.

NORTHAMPTON AND GERALDINE.—I visited the Northampton district with Captain Mitchell and was very distressed to see the extensive plant and buildings going to ruin, the large quantity of good ore at grass or ready for stoping, and Northampton, which almost might be called a deserted village, all at a standstill on account of the low price of lead. There are several old copper mines in the district, one of which Captain Bartley is now testing, and it is to be hoped that he will be successful; but I am very much afraid from the appearance of the ore that it will not contain a high enough percentage to pay unless copper keeps very high in price. Several of the old mines, that were worked at a profit years ago, ought to be starting again now, as everything can be done so much more economically and the market price of copper is again higher.

At the Geraldine two mines are still at work, the South Geraldine lead mine and a copper mine a little farther East on the North side of the Murchison River.

The South Geraldine is being worked by Captain Mitchell, in spite of the low price of lead, at a slight profit owing to its great richness, the large size of the lode, and the shallowness of the present workings. The lode contains from three to four feet of solid galena, which is so clean that it requires scarcely any dressing.

The copper mine on the North side of the Murchison River is also being worked by Captain Mitchell: the lode here consists of rich bunches of grey ore, and being easy to "win" it pays to send it home as ballast in the wool ships.

One very marked feature of this district is the pooriness of the galenas in silver, which seems so universal in this part that I do not think if this metal is found it will be associated with lead, but with copper or iron gossan, specimens of which I shall test when I get the means. This district I hope to visit again shortly, when I intend to speak more fully about the lodes and formation of the country, but it is very difficult to obtain information about these old mines, or to examine them, as the shafts are not safe and are frequently full of water.

THE IRWIN DISTRICT.—Between Geraldton and the Irwin River, after leaving the flats, there is not much beside sand plains with here and there little gum flats as at Allanooka Swamp and Heelan's Swamp. The river above Yaragadee cuts through these recent rocks, and exposes the large clay beds which underlie the sandstone. These beds are seen all the way up to the coal seam, where there is a change, beds of limestone with fossils, micaceous clays, ferruginous sandstones; and clays with beds of coal dipping at about 20 deg. to the North make their appearance; but what relation these beds bear to those seen further down the river I have yet to work out.

The new discovery of coal is just outside the Government reserve on the North side, and up the Northern branch of the river; it is between two and three feet in thickness and appears to be of very fair quality. It is very easy to work, as one bed is seen running away into the face of the cliff, and being within fifteen miles of the Midland Railway, if it answers for steam purposes, will be very valuable.

On the journey back to Perth I did not examine the country off the road, as I propose to return this way better prepared to do so in detail; but it struck me that quite an erroneous idea seemed to exist with regard to it, and I think that if some prospecting were done a little nearer home it would be crowned with success.

FIFTH REPORT.

Issued in December, 1888.

THE COUNTRY BETWEEN PERTH AND GERALDTON, INCLUDING THE IRWIN COAL SEAM.

On September 28th I left Guildford to examine the country to the North-East, and if possible to tap the line of country between the Yilgarn and Berin goldfields; also to visit Bindoon, Arino, Peterwangy, and the coal seam, to examine and make a collection of the fossils at Gingin, Dandaragan, the Irwin River, and the Horse Hills near Geraldton. I therefore propose dividing this report into two sections; the first on the overland road and the coal seam, the second to be a sketch of the country from Berkshire Valley by Jibeding, Ninghan to Mt. Kenneth, returning by New Gulleway, Gulleway and Peterwangy.

For the first ten miles from Guildford the road follows the rich alluvial flats of the Swan, but after crossing the bridge a section of mottled clay is exposed, in a railway cutting through a low hill, very similar in character to the old river deposits and deep leads of the Eastern colonies. The road from here runs nearly due North following for about fifteen miles the course of Ellen's Brook, which is in reality a series of swampy flats with a low range of clay and limestone hills capped with nodular clay ironstone, and ferruginous sandstone, to the East, which would be very suitable for grape growing, while the flats with their black

sandy soil would grow almost everything in the way of vegetables, to judge from the luxuriant manner in which they grow in the one or two gardens there are.

From the junction of the Bindoon Road to Gingin the country is mostly sand, with here and there a patch of swampy ground where the creeks have washed away the sand exposing the underlying clay.

At Gingin the Mesozoic rocks first make their appearance; they are here, where seen in section, ferruginous sandstone, limestone, and clay; the sandstone beds cap all the high hills, the limestones form fine grassy down-like country, abounding in springs at their juncture with the clay, which formation is rarely seen except in some of the deeper gullies; a large part of the land is very good, particularly along the creek, which is always running. Between Gingin and Bindoon there is a belt of sandy country which extends to within about three miles of Atkinson's, where metamorphic rock, with quartz reef, out-crops. Here gold was found some years ago, and a good deal of money was spent in testing a reef which was not considered sufficiently rich to pay, but it had not been properly tested, and to judge from the rich specimens that have been found at different times and the general appearance of the country, I consider that it is well worth a fresh trial. The rocks about Bindoon are clay-slate and sandstone with quartz and ferruginous reefs, granite and diorite dykes. A large lode mostly of hematite with gossany parts should be tested for gold or silver, as should a dyke of diorite, quartz, and mundic. This belt of mineral country runs a little East of North, and, being softer than the surrounding country, the Chittering Brook has cut a valley in it following pretty much the line of strike; this should make prospecting comparatively easy, as there would be no scarcity of water. Mica has also been found near here, and a large quantity was raised, but it proved to be too much discolored with iron to be of any commercial value; this is due to weathering action, and would not affect it in depth.

At Bindoon Hill there is a large dyke of diorite which has weathered into rounded boulders like those so common in the Northampton district; this is simply due to exfoliation from atmospheric causes, not to the action of water, as is often supposed, as the boulders mostly lie scattered on the cap of the dyke. There is always a rich chocolate soil about these dykes which, if not too stony, produces fine crops. The next 20 miles to the junction with the Newcastle road is mostly covered with clay ironstone gravel and ferruginous sandstone, often containing a great deal of white quartz, but the old rocks, clay-slate, quartzite, and sandstone, with numerous quartz reefs, make their appearance here and there where the streams have removed the more recent beds. This country may be said to extend all across the Victoria Plains as far as Waddington, the only difference being that the flats are larger and more clayey, but it is just about the same line of country as passes through Bindoon, and should, I consider, be prospected with a very fair chance of success.

About 30 miles East of Waddington gold has lately been discovered by Mr. Paine in a small isolated range of hornblende schists, called the Wongan Hills. Several claims have been taken up, and the latest reports and samples appear to be very promising. Copper has also been found in these hills, but has not yet been tested.

For the next 45 miles the road bears more to the West, passing through a more hilly belt of country, where the rock, which is of a highly metamorphic character is better exposed, granites and diorites predominating, though there are fewer indications of minerals. The only two discoveries worth noting in this belt are asbestos near Walebing and a beautiful porphyry near Marah. There are some fine rich flats in the neighborhood of the Moore River and its tributaries, and a very good water supply.

To the Westward this country only extends about ten miles, beyond which there is a chain of salt lakes and flats which drain into the Moore River. They

are interspersed with sandy flats and low hills of ferruginous sandstone, but on getting nearer to Dandaragan the country greatly improves, although there is a good deal of sand in places. From the hills near Lyndhurst Mr. W. Brockman has sent in fossils which proved to be of Mesozoic age, and these beds will probably prove to be a continuation of those seen near Geraldton. The sections seen in the gullies are ferruginous sandstone, clay-stone, clay, soft micaceous sandstone, and clay-stone; this last is of great thickness, as all attempts to sink through it have as yet failed. These beds are probably a continuation of those at Gingin, but here the limestone appears to be entirely absent. This is a very common thing, as these limestone deposits are as a rule very local, and when we recollect that the occurrence of these beds is entirely dependent on the accumulation of a large quantity of coral or shells, it is not surprising.

For the next 40 miles North the country is very uninteresting, sand plains predominating; but after passing Carnamah the road strikes to the North-West through country of a highly mineral character.

Between Carnamah and Arino there is the large valley, in which the Yarra Yarra Lakes are situated, that receives the drainage of all the country East to Lake Monger and North-East to the Greenough and Murchison Rivers. This valley being blocked in by the coast hills, the whole country is flooded whenever there is a heavy rainfall Eastward, though in ordinary seasons the Yarra Yarra Lakes are rarely filled.

Between the Lakes and Yandenooka there is a fine belt of mineral country. Copper stains are of common occurrence, and several good lodes have been discovered and worked, but the very great expense of carting the ore to Dongara—over about 50 miles of sandy plain—has stopped their progress. The samples I have seen from this district are mostly green carbonates, and one mass that Mr. Criddle has at Dongara must weigh over a cwt., and would, I believe, assay about 60 per cent. These lodes are decidedly worth a trial, now that copper stands at so high a price. Lead will also probably be found, as this district is very similar to Northampton, and, as there is coal close by, it might be smelted on the spot. All samples from lead, copper, or iron lodes should be tested for silver.

The springs form the great feature of this belt of country; they are generally found on the tops of small travertine limestone hills, all of which have been formed by them; but what is most remarkable is that the water in the springs on one hill varies a good deal in quality. These springs rise from the Carboniferous rocks, which here rest against the low range of crystalline rocks to the Westward, thus forming a basin between it and the Herschel Range.

The country between Yandenooka and the Irwin is all sand except along the course of that river, where there are beautiful alluvial flats; these also extend up to where the river enters the gorge to the South-West of the coal seam.

Just outside the coal field reserve, on the North branch of the Irwin River, Mr. Bell has discovered some fresh seams of coal. On my first visit I thought this, from its appearance, to be lignite, but I find, on examining the fossils from the overlying limestone, that this is incorrect, for they are true coal measure fossils.

These seams are well seen in the cliff section cut by the river, which flows (when there have been heavy local rains) between almost vertical banks of from 200 to 300 feet in height, reminding one of the cañons of the Colorado on a small scale. There are seven seams, varying in thickness from 3 to 8 feet, interspersed with beds of micaceous clay, limestone, and sand, dipping at a slight angle to the North-East. A drive of fifty feet has been put into the face of the cliff on the uppermost seam, which was found to improve greatly in this short distance both in size and quality; this drive I advised them to carry on another 50 feet to get a really fair sample, but at present the men are engaged in testing the lower seam, which is far better looking at the surface than the first seam worked. The

simplicity of working these seams, and their number and size, should make this a very valuable property in the future, when there are more uses for coal in this Colony; but nothing can be done with it till it is connected with a port by railway, as the cartage would make it a very expensive luxury.

A seam has also been discovered by Mr. Whitfield on the South branch of the Irwin, not far from Yandenooka, but I did not see this when I was in the district. The lowest bed of the coal measure series in this district is clay-stone of great thickness; which rather leads me to conclude that the clay beds met with at Dandaragan and Gingin, underlying the Mesozoic, are a continuation of the same bed; should this be the case we cannot tell where coal may next crop up down the coast. The clay beds are overlaid by limestone, micaceous clays (which may prove to be fire-clay), sand, sandstone, coal seams, and shale; there is a great series of all these beds, with the exception of the clay-stone. The whole of these are overlaid unconformably by a ferruginous sandstone and conglomerate of recent age, very similar to what is forming in the river bed at the present day; they are probably a portion of the desert sandstone series of the interior, which as far as I can determine are of terrestrial origin.

The area on which coal may be discovered embraces all the upper branches of the Irwin River, from Yandenooka Northward to the Greenough, as this formation probably underlies the sand plain table-land between these two rivers, though this as yet remains to be proved.

It will be seen from the above that there is a fairly good mineral-bearing country all along the North road, and that mining is simply at a standstill, not for want of material of good quality, but on account of the expense of carting; and if the Midland only goes ahead we shall have a number of flourishing mines along it in a very short time: also, as the railway will pass within fifteen miles of the coal seam, there would be a branch line run to it, if the company did not find the coal on their own land on the South branch to be of any value.

SKETCH OF THE COUNTRY PASSED OVER ON A TRIP NORTH-EAST FROM BERKSHIRE VALLEY TO MT. KENNETH, RETURNING BY PETERWANGY.—From Berkshire Valley to Edawa, a distance of 16 miles, the country is mostly granite with patches of alluvium and sand, but destitute of any mineral veins. After leaving Edawa there are first 11 miles of very heavy sand, and then small rocks and yellow clayey flats for 5 miles to a rock-hole in a mass of graphic granite. From there to Jibeding, 29 miles, are alternate patches of granite, clay, and sand.

Jibeding is on the edge of a large salt lake, probably part of Lake Moore, as similar flooded salt country (with here and there a protruding mass of granite) extends to the Ninghan Range. This range is a lofty group of hills rising between Lakes Moore and Monger, and attaining its greatest elevation (about 4,000 feet above sea level), in a big mass of dolomite sandstone, called Mt. Singleton, or Ninghan. The rocks in the rest of the range are slate, quartzite, hornblende rock, granite, and amygdaloid, with ferruginous jaspery quartz veins and hematite lodes, which latter should, I think, be tested for copper and silver.

There are several isolated ranges to the North, North-East, and North-West beyond the Lake; which would, in all probability, be also worth prospecting.

Between Ninghan and Mt. Kenneth there is very little of interest from a miner's point of view, as it is mostly flooded ground, with a little granite here and there. There is a ridge of desert sandstone on the West side of Lake Moore at Goodenow.

Near Mt. Kenneth there is an entire change of country, flat-topped hills, quartz reefs, ironstone lodes, and large alluvial flats. This country is of a very

promising character for gold, and I should like to have spent some time examining it, but was prevented, as the water was so salt that it made the horses ill.

Mt. Kenneth is a very big flat-topped hill, which can be seen a good distance, as the country rises towards its base for about ten miles; it is nothing but a steep cliff about 100ft. high, the top of which rather overhangs, making it very difficult to climb. The lower part is of a ferruginous quartzite, dipping at a high angle to the East, whilst the top is horizontally bedded desert sandstone. The rocks of the lower ridges and outcrops in the flats are clay-slates, quartzite, mica schist, sandstone, and granite, with many quartz reefs. Gold will in all probability be found here, and water should be easily obtained in the large flats at no very great depth, and as Mr. Morrissey informed me that there are a great many natives in the bush about here, there must be an abundance of surface water, or springs, as yet unknown to the settlers. From a grazing point of view, I have never seen better country for both salt-bush and grass; and it seems strange that so little of it should be stocked, situated as it is only two hundred and fifty miles from Dongara.

Further North this country extends about sixteen miles, after which we get sandy plains and bold granite hills up to Mr. Broad's station, which is situated on the side of a small quartzite range running North and South, in which there are some reefs, but not of a very promising character. After crossing the range there are clay flats and masses of granite, to Mr. Oliver's station, and this class of country extends to Jarraminda water-hole. From this the road follows up a small salt creek, with water-holes, for thirty miles in a North-Westerly direction, with granite in the bed of the creek and desert sandstone cappings on the high ground. The latter forms a large scrubby table-land as far as the eye can see to the North-East and North; it is bounded on the West by the Northern extension of the Minjar Range, which is crossed by the road a few miles from Badgera, where the rocks are clay-slate and quartzite on the East side and granite on the West. In this range there are some very rich-looking quartz reefs, which I think should be prospected.

The next thirty miles of country Westward is flooded ground, with lakes here and there and masses of granite rising to the surface, but forming no hills till you come to Gulleway springs, which are situated amongst some bold granite hills rising out of alluvial flats. This class of country extends North towards the Murchison, and West to Peterwangy, with here and there some small outcrops of slate, with quartz reefs and ridges of desert sandstone.

Peterwangy is situated on the line of escarpment of the old crystalline rocks, which extends from the South to here, and probably once formed the coast line. Gold was found here some years ago in small quantities, but never paid to work. The rock is granite with some quartz, and overlaid in many places by clays, which are probably old alluvial deposits; and it is, I believe (judging from the waterworn character of the gold) from these deposits that the gold has been derived, as the rocks and reefs about the diggings are not at all promising in appearance. Granites themselves sometimes contain a small quantity of gold, and this may be the case here; but if the gold about here has come from reefs at all, I should think that it came from the country which is further up the Irwin, where are some very good looking reefs.

As a whole—this country is not very interesting, though round about Mt. Kenneth I think gold is certain to be found. Mt. Singleton Range, and the Minjar Range should also be prospected.

WORK DONE IN 1889.

Immediately after the completion of my Annual General Report for 1888, I proceeded to Newcastle, Goomalling, and Wyening, to inquire into some reported discoveries of coal.

My second trip was to the country South of Perth, visiting Bunbury, the Vasse, the Fly Brook coal seam, and the Warren; then returning to the Vasse, and Bunbury, on to Bridgetown, and the Tinfields, overland to Albany, Eastward to the Fitzgerald and Phillips Rivers, to report on the supposed coal seams, then back to Albany, and by rail to Perth.

I was next employed in reporting on the prospect of Artesian water being obtained by the Government on the Eastern Goldfields, and in this trip I included Golden Valley, Southern Cross, and Parker's Range.

I then went to the North to continue the work of the previous year, travelling *via* Newcastle, the Irwin coal seam, then across the Mullewah and the Greenough River, to Northampton, the Geraldine, up the Murchison River to Milly Milly, across to Mount Claire on the Gascoyne, and down this river to Carnarvon.

During this year I have travelled about 4,000 miles on service, mostly by road, and have mapped about 64,000 square miles of country.

THE COUNTRY BETWEEN PERTH AND BUNBURY, VASSE, AND FLY BROOK.

Report issued June, 1889.

On the 12th March, 1889, I left Perth for the South by the main Southern road, along which, between the Swan and the Canning Rivers, are sandy and swampy flats similar to those between Guildford and Fremantle, the sand being probably derived from the weathering of the soft sandstone of Tertiary age, which are exposed along the coast in places, and in the banks of the Swan and Canning, forming high cliffs where the rivers have cut through them.

These sands often contain a large percentage of clay, lime, and iron, and in some places are so clayey as to be quite impervious to water, and then swamps are formed, which are often covered by a rich peaty soil that if drained and cultivated, as in the Chinamen's gardens in Perth, will grow almost anything; though even the sands themselves, as in Mr. Moore's garden, near Fremantle, are wonderfully adapted for the growth of fruit trees and grape vines—in fact, all this land, now only covered by thick, useless scrub, will, before very long, I feel confident, be one magnificent garden.

After crossing the Canning bridge, the road passes along the alluvial plain on the Western bank as far as the town-site of Kelmscott, where the river turns to the East passing into a deep gorge in the range, while the road, crossing over the foot of a spur of the range extending Westward, leads on to Narrogin.

On the Canning, some years ago, a bore was put down about 170 feet to test for coal, but the record of what was actually passed through seems to be lost,

except that some beds of a carbonaceous clay were met with just before the rods broke, and the work was abandoned. There are many quartz reefs and dykes near the foot of the ranges; in the *débris* of these, in the river bed, several minerals were found by Mr. Gregory, proving that lodes do exist in this locality, which should encourage prospectors to examine the district, and they would be much assisted by the fine section cut up by the river through the range, where both the lodes cut and the detritus derived from them might be easily examined. It is needless to add that any mineral discovery in this district would be of the greatest value on account of its nearness to a port and the capital, so that the expense of cartage would be slight, and the mining could be easily and cheaply done.

The rocks at the foot of the range are slate, sandstone, and quartzite, capped with ironstone gravel, sand, and ferruginous sandstones, with rich patches of alluvial soil in the gullies, as at Narrogin, on which orange and other fruit trees seem to thrive wonderfully.

Similar country extends to within a few miles of Pinjarrah, the only other rock exposed being at the Government Well on the Serpentine River, where we find a coarse, white, quartz grit; but what relation this bed bears to either the crystalline or the more recent rocks it is impossible to say, as the whole surface is covered with ironstone gravel and alluvial deposits.

At Cardup and Jarrahdale some lead lodes were opened some years ago, but were found to be too small to work, although the lead carried a fair percentage of silver.

A few miles North of Pinjarrah the country opens out into the fine alluvial plains of the Murray River, on which there is some very fine land, though most of it towards the coast is covered with sand, which extends down towards Peel's Inlet.

In the ranges to the East of Pinjarrah, tin and silver were supposed to exist, but, unfortunately, the silver proved to be white mundie (marcasite), and the tin to be oxide of iron; but, from the general appearance of the rocks, which are granite, mica schist, quartzite with felstone dykes, and numerous nice looking quartz reefs, which run North and South, dipping sometimes East and sometimes West, I should advise the prospectors not to give up, but to confine their attention more to prospecting the gullies, leaving expensive sinking in rock until they have been able to trace fragments of mineral to the vicinity of some lode, or have found it in the stone itself.

Between Pinjarrah and Bunbury, for the first ten miles, the road follows the alluvial plain on the West bank of the Murray River, until it turns to the East and cuts into the range. From this point the road runs in a Southerly direction on the plains at the foot of the hills over sandy and alluvial flats and low spurs capped with ironstone. After crossing the Collie River the road turns West towards the coast, leaving the range and crossing the alluvial flats towards Bunbury.

In the neighborhood of this town there is some of the finest land in the Colony, which, owing to the fine climate and good rainfall, will grow almost any crop, but for some reason very little of the land that was formerly cultivated is now worked, and I was greatly surprised to see a cargo of wheat landed in a district that could grow enough to supply the whole of Western Australia.

At Bunbury a dyke of columnar basalt out-crops on the beach, appearing to run in a Southerly direction towards Black Point, on the South coast, as it makes its appearance here and there between these two places.

A few miles from Bunbury, on the Preston River, are some old workings, where two or three pits have been sunk down to the water level, with the idea of prospecting for coal, as some carbonaceous matter had been found in the bank of

the river associated with sandstone and clay. These pits have now fallen in, and the *débris* from the cliff has quite covered any exposure there might have been in the river bank, so I was unable to see anything; but it is highly probable that a modern coal or lignite may be met with here, and I should very much like to see a bore put down. I think that in cases like this the Government should allow a person or company to test land without taking up an area, then give the first chance of selecting a claim to the fortunate discoverer of any valuable mineral.

Between Bunbury and the Vasse the country is for the most part sandy, with here and there clayey swamps and fine alluvial flats along the streams.

About three miles from the Vasse there is an outcrop of a very compact, grey dolomite limestone, the age of which is uncertain, as no fossils have been met with in the stone, which has only been taken from the small excavations near the lime kilns, but from its crystalline appearance I should judge it to be a good deal older than the earthy white Tertiary limestone of the coast.

From the Vasse the first ten miles to the South-East are mostly sandy and swampy, but then the road ascends into the spurs of the range, which are covered with ironstone and ferruginous sandstone, as far as St. John's Brook, where the crystalline rocks are exposed, and continue to out-crop to the Lower Blackwood Bridge. Between this and Mr. Brockman's, on the Warren River, the country is mostly hilly, the ridges being capped with ferruginous sandstone and patches of waterworn boulders, while in the gullies, granite, quartzites, etc., make their appearance. The land here is very good, but so heavily timbered that it would almost take a fortune to clear it, though between this range and a small coast range that runs from Cape Naturaliste to Augusta there is a large belt of swamp land, highly suitable for the production of root crops, and, as Mr. Dickson informed me that he got three crops of potatoes out of the same land in one season, one naturally comes to the conclusion that this land ought to pay well to work.

The Fly Brook is the furthest branch to the South-East of the Donnelly River, which discharges itself into the Southern Ocean about thirty miles East of Cape Leeuwin. It is always running as there is as large a rainfall here as in any other part of Australia, but, unfortunately, it is not navigable, the good-sized estuary at its mouth being closed in by a sand-bar; the nearest ports that ships can use being Augusta and Hamlin Harbor, which are about 30 miles to the West.

On this Brook some coal mining leases were taken up last year, but the existence of these seams appears to have been known for many years to some of the older inhabitants. Several reports had been made on it, and in most of these the opinion was expressed that it was only a charred log, which fortunately proved to be incorrect, as we now know that four seams of a good lignite out-crop in the gully. These are, at present, being tested in a systematic manner by Mr. Richard Baxter, who is putting down a series of bores to determine the number, size, quality, and extent of the seams, which he has already shown extend over the whole area taken up, the large seams being easily identified when met with in the different bores by their persistent thickness, associated beds and partings, but, up to the present, he was unable to test the entire thickness of this formation in the deep ground, as there was so much water that the bore hole was continually falling in. This difficulty he will now be able to overcome by means of tubing, and is working with the intention of boring till he comes to the bed rock. In one of the bores (sections of which both Mr. Baxter and Mr. Ross have been kind enough to send me), we find that they have passed through about 20ft. of lignite in sinking to a depth of 128ft. This consists of seventeen seams, the largest of which were 5ft. 4in. with a 6in. clay parting, 2ft. 4in. with a 3in. parting, and 2ft. 3in. with a 2in. parting. Several other seams, up to a

foot in thickness, could also be worked, as several occur close together with shaley partings.

The lignite itself is a highly lustrous variety, having almost the appearance of jet, but lacking its hardness, while the woody structure is clearly visible in some pieces, and on assaying it proved to be almost identical in composition with the cretaceous coals of the Pacific coast of North America.

The average of three samples of Fly Brook coal, assayed in Melbourne and Adelaide, and three samples of American is:—

		Fly Brook.	America.	N.S. Wales.
Water	...	16.40	14.00	2.22
Volatile matter	...	38.23	38.17	29.94
Fixed Carbon	...	43.52	44.14	58.99
Ash	...	1.85	3.69	8.85

I have also added an average of 94 samples of coal from New South Wales for comparison, and it will be seen at once that the two great points of difference are the quantity of water and fixed carbon, and, although the Fly Brook contains so much volatile matter, chiefly hydro-carbons, it cannot be profitably employed for gas manufacture, as it is non-caking; that is to say, the coke it forms is in a state of powder and so of no commercial value—and gas companies rely on the sale of coke for a large proportion of their profits, but, as the similar coal in America is used largely for steam and other purposes, there is no reason why this should not turn out to be of great value to its owners and the Colony generally, the great drawback being the distance from a port, and the large percentage of water it contains, which renders it too friable for much handling. It is sure to be said that the samples sent away were no test, as they came out of the creek bed, but this will not make the slightest difference, as the superfluous water would have had plenty of time to evaporate before it reached the assayers' hands, and the lignite from a depth will be found to contain quite as much, for all lignites or recent coals are distinguished by their high percentage of water.

The exact age of this lignite I was unable to determine, but, from its character and the general appearance of the country, I should certainly consider it to be Mesozoic; still, considering its position and the number and size of the seams, it is, as I have before stated, a very valuable discovery.

The coal-bearing series here consist of sandstone grits and clay beds (the latter of which are often micaceous), the whole being overlaid by a bed of ferruginous conglomerate, containing large waterworn pebbles of quartzite, quartz, and other crystalline rocks. This bed is met with in many places in this district, and probably forms the junction between the series and the more recent clays, sands, and ironstone which cover most of the surface. From what I have seen, and gathered from Mr. Baxter, who has examined most of this district, I have come to the conclusion that this formation will be found to extend over a considerable area, at first in a North-Westerly and then in a Northerly direction, towards the Vasse, where some samples of a less highly mineralised form of lignite have lately been found in sinking a well. This can only be ascertained by boring, as, with the exception of the Blackwood valley, most of the surface of this belt of country is covered with sandy or swampy ground. A few bores put down to the bed rock would be of great interest, as we should then know for certain if true coal measures exist beneath these more modern deposits.

BUNBURY TO BRIDGETOWN, THE TINFIELDS, AND ALBANY.

Report issued June, 1889.

The road for the first fifteen miles from Bunbury runs along the alluvial flats of the Preston River (where there is some most fertile land) to the foot of the range, which here is covered for the most part by clay and ironstone; outcrops of rocks occur in the river valleys, as do also many rich patches of land. Similar country extends to the Tinfield, which is situated on the road about eight miles North-West of Bridgetown.

TINFIELD.—The Tinfield is situated on a ridge on the North-East side of the Blackwood River, and between two of its branches: most of the best prospects have, however, been found on the Southern side of this ridge. The greater part of the surface on the high ground is covered with ironstone gravel, with here and there outcrops of hard crystalline rock and dykes of diorite and tourmaline, some of the crystals of the latter being of enormous size. The low ground is covered with sand, and is, where springs break out, rather swampy, so that very little can be told of the rocks till some shafts have been sunk.

On the ground belonging to the Bunbury syndicate a shaft has been sunk and the ground tested to a depth of eighteen feet on the North edge of the claim, which was discovered by Mr. Stinton, who obtained prospects in the wash from a little gully that crosses this claim, but, on sinking deeper, he found that this rested on a false bottom of ironstone, in which there were some pockets containing a good deal of tin ore, though very little in the ironstone itself. Beneath this bed he went down some sixteen feet through a coarse quartz grit containing very little clayey matter, but much rich tin ore and a good deal of tourmaline. This deposit has not yet been bottomed, but is so rich all the way down that a man might make a good living by simply washing with an ordinary dish, for what has been raised goes 4lbs. or 5lbs. to the dish. Fine colors of gold have also been found in this wash, proving that this country is gold-bearing, and there is every probability that some rich pockets of the precious metal may be met with when the wash is bottomed.

This shaft has, probably, been sunk in what would be called a deep lead in the other colonies, and will have no connection with the present gully, but will most likely be found to pass through the low rise towards the swampy ground near the spring to the South, or a little South-West, but the actual course can only be ascertained by sinking, as the surface is all covered alike by more recent deposits. Prospects of fine tin can be obtained nearly all over the field, even from sand at the surface, but, as little prospecting has yet been done, I can say nothing about the different claims, moreover, when I visited the field no one knew where his claim was for certain: but, judging from the one shaft, this is a most valuable discovery, and it extends over a large area, as I have obtained small prospects over most of the field. I hope that everyone will do what he can to test and develop this most important discovery, as all the claims are worth a trial, but which of them will pay to work must be left to the owners to prove.

That rich lodes exist on this field there is not the slightest doubt, but where, it is at present impossible to say, though probably one will be found not very far from Stinton's shaft, and to judge from the class of wash, it will consist of a series of small veins or strings of coarse crystalline tin ore (cassiterite) in a soft, large-grained granite.

The rocks of this district, where exposed, are nearly all gneissic and schistose, containing numerous dykes, though in one or two holes where rock has been met

with near the surface, it is so soft that it can be worked with a pick, and it will most probably be in this soft belt of country that the lode will be found.

I would recommend prospectors to examine the Blackwood River, and the small streams that feed it from this side, as the field will most likely be found to extend in this direction.

The field should be very cheaply worked, for there is a good fall towards the Blackwood, and, as there is an abundant rainfall, there will be no scarcity of water; while it is connected, by one of the best roads in the Colony, with the port of Bunbury, which is about fifty-six miles distant.

The country about Bridgetown is very similar in character to that around Newcastle; steep hills with deep, rocky valleys, and patches of good soil almost to the hill tops. Between Bridgetown and Albany there is some beautiful land which is heavily timbered, though at places there are patches of ironstone gravel, while sandy swamps and outcrops of rock occur in the river beds. Next year I hope to be able to follow some of these rivers down to the coast, as in them only does one get a chance of seeing anything like a section of country, and some specimens I have seen from the Deep River would lead me to believe that the same formation as occurs at Fly Brook extends round this South coast as well as to the North, and it probably crosses the Warren a little North-East of Brockman's. This is of very great importance, for the nearer to Albany is coal found, the more valuable will it be.

ALBANY AND EAST TO THE PHILLIPS RIVER.—For about fifteen miles to East and West, and thirty to the North of Albany, the country is for the most part covered by low swampy and sandy ground, though here and there bold granite hills rise to a considerable height above it. This land is highly suitable for growing vegetables, as is proved by several small gardens around the town, and there should be a large future for this industry, in supplying the ships that call in here.

After crossing the Kalgan River, the country gradually rises, forming a large open table-land about 200ft. above the sea, with here and there bold peaks and ranges of hard crystalline rock towering above it, and in other places large patches of broken country, where the rivers have cut their way down through the soft horizontally bedded sandstones to the highly altered clay-slates and quartz reefs beneath, some of which, as in the Pallinup, Fitzgerald, and Phillips Rivers, should be prospected for gold, where the stone is of a very likely character, greatly resembling that on the goldfields of the other colonies, and the more especially as this is in all probability the Southern continuation of the same line of country as that in which the Yilgarn goldfields are situated.

Near Middle Mt. Barren a mine was started for copper, and a good deal of work done on a lode; but I should not advise the prospectors to continue this work, or to spend much time on the hard coast ranges, as they are not of a highly promising character for valuable minerals.

In the bed of the Fitzgerald, some years ago, Captain Roe discovered what he thought to be a coal seam, but it has, unfortunately, proved to be nothing more than a brown carbonaceous substance, containing a certain amount of asphaltum. These deposits of coaly matter occur in a series of pockets or hollows resting on the upturned edges of the altered slates and quartz reefs, and are often full of angular fragments of quartz. It will not burn by itself, but, if put into a large fire, smokes and gives off a strong smell of asphalt, and is finally reduced to a firm, bulky ash of a reddish color. It is not a coal, and will never be of any commercial value as a fuel. No carboniferous formation exists here, and in this conclusion I am supported by Mr. H. L. Y. Brown, F.G.S., Government Geologist, S.A., and the Rev. C. G. Nicolay, M.A., both of whom visited and reported on

this deposit. What, I believe, led Captain Roe to believe coal existed here was the fact that all along the Southern coast of Australia large quantities of mineral pitch (bitumen) are washed up on the beach. Some of this he found at the mouth of the Fitzgerald, and, thinking that it must have been washed down, followed up the stream bed till he came to this deposit, from which he imagined it had come, as when wet it is black and has all the appearance of a weathered coal.

In the river flats there are some very fine patches of land, which are farmed at Cape Riche and the Gardiner River, but most of the broken country is covered with such dense thickets, that nothing can be done with it, while on the top of the sandy table-land no trees grow, except in occasional swampy patches. A great drawback to this country is the scarcity of water, as the good rainfall does not extend far into the interior, so that the rivers only run after heavy thunderstorms and these of late appear to have been of very rare occurrence. I am very sorry that I could not extend this trip further to the North and examine the Stirling Range, as was my previous intention, but, by the time I arrived at the Phillips, my horses had got into such a low condition, that I thought it best to get back as quickly as possible by the way I knew; but I hope at no very distant period to revisit this district, when I shall make a point of seeing the Stirling Range, though, to judge from its general appearance from a distance, I do not think it would pay prospectors to spend much time in looking for lodes, for it has generally proved that a hard, bold range, rising up from low ground, is not rich in metalliferous veins, but the low ground around the base of the range, where low ridges of soft rock out-crop, is far more likely to reward research.

KENDENUP.—At Mount Barker and to the North the country changes entirely in character. Crystalline and metamorphic rocks with numerous dykes and quartz reefs make their appearance, capped on all the high ground by iron-stone gravel and clay, with patches of very good land along the valleys. Some years ago, in one of these reefs, at Kendenup, gold was found, and although the assays yielded very good returns, yet, on mining, very little gold was obtained; whether from defective machinery, the mode of working, the large amount of mundic (which, although roasted, might not have been entirely decomposed), or the fact that the gold is very patchy in the stone, it is impossible now to find out; and as the tailings have been much washed about, it would not be much use testing them to see if they contained the gold; but, to judge from the appearance of the stone and the assays of the stone sent away, I think the mine ought to have another trial, as it would have a very fair chance of success if properly worked, especially as such great improvements have been made in machinery of late. There are several other reefs on this property that still remain to be tested, and there is also an old shaft that was sunk on a vein containing graphite, which, now that the railway passes so close, should pay to work; in any case, a sufficiently large sample should be sent home to ascertain what the present market price is.

Taken as a whole, this trip has been most important and interesting. In the first place I passed along a line of country between Perth and the Fly Brook, in any part of which coal may exist, but this can only be proved by boring here and there in a systematic manner. Whether true coal measures exist, or not, we know that we have a good deposit of lignite, though a more recent formation, still a very useful fuel, and in several other places indications that these beds exist over a considerable area. Whether this country extends to the East it is impossible to say at present, but we know that some beds of lignite exist near Torbay, and, though of poor quality, there is no reason why better ones should not exist beneath them. If this belt of country were properly tested, the matter would be set at rest once and for all, and we should know whether this was going to be a great coal mining country, or whether it would be better to settle down quietly to farming.

The tin is also of great importance, and should prove of immense value to the Colony, if properly worked, and though many of the claims will, undoubtedly, prove to be of no value, others, there is not the slightest doubt, will be very rich.

THE YILGARN GOLDFIELDS.

Report issued July, 1889.

In this report I do not propose to give a description of all the claims on the field; because I had not time to examine them all, and, moreover, in the majority so little work had been done, that no satisfactory conclusion could be drawn of their possible value. I shall therefore only mention those claims that have been sufficiently opened up, or upon which there is a large enough body of stone in sight, to warrant their owners in putting up machinery at once.

Since my last visit to the Northern portion of these fields, most of the claims, which then extended for miles over the country, have been abandoned, even before they had been thoroughly prospected; and this is just as well, for, as it is, there is still a good deal more land taken up than can be properly developed by the limited capital available in this country, and outside capital will not be invested until some of the reefs have been proved in value and extent: consequently we should devote all our energies to ensure the success of some of the richest areas, and leave the poorer and more difficult until the fields are well established.

GOLDEN VALLEY.—I start with the Waterhall claim, as it is on the most important reef, as far as at present known, in this part of the field. This area is comparatively small for this district, where thirty-three acres is about the average extent, and it is of an irregular shape as it was taken up at a later date and had to fit in with pre-existent claims. It is in the middle of the valley to the South-East of the Kathleen. The reef was discovered beneath the bed of a little gully and a large *paddock* has been opened on its cap which appears, as far as I can at present judge, to be the top of a saddle reef, one leg of which can be clearly seen to dip to the East, while the other plunges almost vertically down at the West end of the hole, while the country which consists of a compact mica schist on the foot-wall and a hornblende schist on the hanging-wall, has the same anticlinal fold as the reef. This form of reef is characteristic of the Sandhurst district of Victoria, but whether here, as there, both legs will be found to carry gold as they descend, and one saddle below another will be found, can only be proved by sinking; but I am of opinion that this is a true saddle reef, for parallel beds of identically the same rocks occur on the hills to the East and West, with lines of reef of the same description, which may be the legs of a saddle whose cap has been denuded. On the cap of this reef a large body of stone is exposed mixed with fragments of the bed rock. This stone is sometimes white, solid, and granular, but usually it is more like a gossan and contains hematite, iron and copper pyrites, and chlorite, and shows much bright, coarse, free gold in the solid stone; in the gossan and on the faces of the small ferruginous veins some very fine specimens have been obtained, which will make the first crushings very much richer than those that will follow, for this gold is only the alluvial deposit which is generally met with in the caps of auriferous reefs, and does not continue in depth.

A shaft has been sunk, a little to the South of the paddock, to a depth of forty feet; it cut the reef at twenty-four feet, where it was found to be much more settled; it dipped to the East and had a course a little to the West of North, and was about three feet six inches wide. At the bottom of the vertical shaft, thirty-two feet below the surface, a level was driven twenty feet North and South following the course of the lode, and from this another eight feet was sunk. The stone from the

shaft and level is similar in character to that at the surface, but less broken; it shows gold freely.

Although this reef has nothing to speak of in the way of walls, yet from its character at forty feet, and the fact that it extends some way both to the North and to the South, and the character and persistency of the other parallel lodes, I believe this to be a true vein and to offer every prospect of a very profitable mine.

I would advise following this reef down on the under-lay to the water level which will probably be some thirty or forty feet lower, and also extending the level in a Southerly direction to ascertain the extent of the gold-bearing stone.

On the Kathleen claim there are two reefs carrying gold, the one towards the Eastern side of the valley being that first discovered on the field. This reef goes down so vertically that a shaft of 83 feet has continued in it almost all the way down. It has an average thickness of forty-two inches, though at the bottom of the shaft it is only twelve. It is a good deal broken and at one place has been thrown quite out of its course, and so was lost for some time.

Some stone from a depth of thirty feet was sent away for a trial crushing, and gave, I believe, satisfactory results. The gold in the reef is very fine and rarely visible to the naked eye, but will probably pay on crushing.

In the course of constructing a dam on this area, a Northerly extension of the reef that is being worked on the Waterhall claim was discovered in the middle of the valley. A large paddock was then opened up on the cap, exposing a large body of stone, very rich in gold, and a most satisfactory find, proving, as it does, that the Waterhall reef is not a small patch, or shoot, but a large reef, rich in gold, and extending for a considerable distance.

Another shaft is now being sunk higher up the valley and will be carried down to the water-level, in order that the owners may determine if it be good enough to warrant their putting up machinery, though on this question I do not think they need have the slightest hesitation, for the stone now being raised is some of the richest on the field, and has already been proved to be of considerable extent. The stone in this shaft is rather more glassy and ferruginous than that in the other, and contains a good deal of gossan and hematite in places, with here and there a little copper. The whole mass shows gold freely, and in some of the gossan it occurs in small pellets about the size of a pea, which, on being touched, crumble into a fine, gritty, gold powder, while in other parts heavy coarse gold is found. This lode will probably, at the water-level, consist of auriferous copper and iron pyrites, as the gossany hematite cap is derived from the decomposition of those minerals.

Reefs of this description must be carefully worked, for these very rich patches are not likely to be of any very great extent, but by taking the richer with the poorer, and prospecting well ahead, this will, in my opinion, prove a very valuable property.

On the Edith, Marion, and Judith Keaven claims, not sufficient work has, as yet, been done to make it possible to form any opinion of the value of this reef. On the Edith a long tunnel has been started into the hill, but has not yet cut the reef. On the Marion there are two shafts on the same reef, fifty-eight feet apart, one twenty, and the other fifty feet deep. In the latter shaft the reef is two feet wide at the surface, four feet at a depth of thirty-five feet, and then thins almost out, but is beginning to make again at the bottom. The Judith Keaven is as yet untested.

Hope's Hill is situated about thirty miles South of Golden Valley; it consists of a large hill of white quartz of a very unpromising character. Gold was first found at the foot-wall, the East side of this reef, in a white magnesian clay, full of quartz grit. On this side of the reef there is a mass of whitey-brown and greenish-blue banded clay, probably resulting from the decomposition of a

serpentine rock, full of small quartz leaders, of a curious gritty nature. These leaders are, as a rule, rich in gold, and in some parts gold is also met with along the joints of the clay, but for the most part it is not visible, though, on crushing, good prospects are obtained. The bulk of the reef is a white stone of barren appearance, though here and there are bands containing more iron, and which yield, on crushing, very good prospects of gold. The reef, which is about fifty feet wide at the surface, seems to be in reality a series of reefs separated by partings or casings of a white greasy clay. It is now being tested by a cross-cut, and in my opinion the richest stone will be found in the mass of leaders to the East of the reef; and if any gold be found in the main portion, it will be useful for crushing with the mullocky portion. Unfortunately it is a protection area, on which it is only necessary to keep two men at work, so that very little has been done. Two shafts have been sunk, one on the East following down the under-lay, while the other on the West is vertical and is now thirty-seven feet deep, and between these a cross-cut is being put through the entire thickness of the reef. No gold was visible in the stone, but what I crushed gave good prospects, and, although it cannot be foretold how much of the main mass will pay for crushing, I do not in the least doubt but that there is sufficient to ensure a very prosperous mine.

Ridley's claim is the next on the Southern side, lower down than Hope's Hill, but of very similar character. A shaft has been sunk on the foot-wall side of the reef to a depth of sixty feet, and then a cross-cut made of sixteen feet through a mullocky lode full of quartz leaders carrying gold, which, as in Hope's Hill, appear to be the richest portion of the lode. Several cuts have been made on the surface of the outcrop of the reef and good prospects obtained. All these circumstances taken together should encourage the shareholders to thoroughly test this area.

Further to the South, on the same line of reef, is the claim known as the Two Brothers, where a shaft has been sunk for eighty feet; at thirty-five feet a level was driven fifteen feet along the reef, and at the bottom a cross-cut of sixty-three feet to the North-East, and thirty-seven feet to the South-West. In the first of these a mass of banded mullock, full of quartz leaders, many of them ferruginous, all carrying gold, were cut through, while to the South-West the main reef was cut, which here proved to be of solid white quartz, and from which no good prospects were obtained. On the other hand, good prospects can be obtained from any of the leaders passing to the North-East, and in many places *point* gold is met with on the floors, faces, and through the clay; it is often very fine but sometimes tolerably thick.

Considering the enormous mass of gold-bearing stone, there cannot be the slightest doubt that this property will pay very well, provided that all the fine gold can be secured by any process. A good plan would be to send two tons of the stone just as it is raised, one to be treated by the ordinary crushing plant, and the other by a Huntingdon Mill.

SOUTHERN CROSS.—Southern Cross is situated about thirty-five miles to the South of Golden Valley. There are here a series of reefs running more or less North and South, and which appear to have been formed at different periods, but without carefully mapping this district, after it has been sufficiently opened out, it is impossible to express a certain opinion on this point; but, for the present, it is enough to say that there are three lines of true lodes, one white, one ferruginous, and one mullocky with quartz leaders, and one series of cross-courses.

These true lodes apparently owe their origin to the great upheaval which has taken place on the Eastern and Western sides of this area, to which they run parallel, while the cross-courses are due to a later intrusion of granite, masses of which stand out as bold, bare, isolated hills.

The country is of comparatively slight elevation, consisting of low thickly timbered hills, flats, and clay-pans, or lakes, the reefs for the most part appearing on the low ridges, but in some cases they are also visible on the edges of the lakes.

The rocks are chiefly hornblende schists, but micaceous, chloritic, and talcose schists also occur, while both to the East and West metamorphic and intrusive granites appear, and occasionally trap dykes are found.

The Central claim has been taken up on a huge reef that can easily be traced from one end of the area to the other, and which shows gold freely in all the pits that have been sunk. The exact width of the reef is as yet unknown, for these surface pits afford no safe criterion for forming an opinion on such a question.

The stone contains many minerals in small quantities, *e.g.*, galena, copper pyrites, iron pyrites (mundic), and chalybite (carb. of iron), and it is well studded with gold, while near the surface many of the specimens are exceedingly showy, owing to a deposit of semi-alluvial gold which has found its way into the cracks and fissures.

On this claim there is a large amount of rich quartz in sight, that only needs to be quarried and carted to the stampers. I would, however, strongly advise the directors not to be in too great a hurry to pay a dividend; but as soon as returns are obtained, to sink a main shaft and open up this reef. As up to the present only a water-shaft has been sunk, the water stands in this at a depth of fifty feet. For although there is so much rich stone at the surface, it is highly probable that at a depth the lode will pinch, and not pay working expenses for a considerable distance, but then lower down will again widen and pay, and such pinchings and widenings may recur several times before a depth of two or three hundred feet has been reached, consequently if a reserve be not kept in hand to tide over the unproductive part of the working, this promising mine might have to be closed.

As the machinery for crushing is now on the field, we shall doubtless within a month or two know the true value of the stone in sight; and I do not think that any but the over-sanguine will be disappointed in the results.

A very rich deposit of alluvial gold has been found in the little gully that runs down from this reef; and it is most probable that when the ground is fully prospected by experienced diggers, many more of these will be discovered.

At the Southern end of the Central claim is the area that has been taken up by Fraser's Company. It has a huge body of rich stone at the surface, more iron-stained and with more gold visible in the faces and joints than in the Central stone, though in the solid stone I did not see as much; but this may be due to the fact that that company was not opening up a rich patch, while the heaps of stone on this claim had probably been well picked over.

This claim has been opened up in a more satisfactory manner than any other on the field, for a shaft has been sunk to the water-level, a depth of forty feet, and then a level has been driven forty-six feet in the body of the reef, and at each end of this cross-cuts have been made to ascertain the entire width of the reef; which in the first of these, that at the bottom of the shaft, is thirty-seven feet from wall to wall, and in the other thirty-three. The whole of this width is not solid quartz, a good deal consisting of a clayey deposit containing ferruginous quartz and hematite leaders, yet the mass is rich enough in gold to pay for crushing.

I believe that it was intended to test this mine to a great depth, but sinking had to be stopped on reaching the water-level, which, owing to the low situation of this claim, is very near the surface.

The machinery will shortly be erected, and as there is a great mass of stone at grass and a good dam full of water no delay will occur in getting a

crushing, and from this mine as well as from the Centrals there is not the slightest doubt but that the returns will be very good.

The Phoenix area, or areas, are situated on one of the black or ferruginous lines of reef running parallel to the Central's and Fraser's on their Western side. I should say that more work has been done on this claim than on any other, but it appears to have been done without any system, and where reefs have been struck in depth they are either barren or too small to be worth working. The best thing now will be to start afresh from where the gold was originally found and follow it down, for in this broken country no rules exist for picking up lost reefs or selecting a place for cutting one in depth.

On another line of reef a little further West is the Exchange claim. The stone is a yellow mullocky mass with quartz leaders carrying gold on the foot-wall side at twenty feet below the surface and down to the bottom of the shaft which is now sixty-eight feet. The whole lode mass is five feet wide and gives good prospects in places, but how much of it will pay for crushing remains to be proved. It will be advisable to run a level at the bottom of the shaft to ascertain how far the gold extends along the course of the lode.

With regard to the other claims I can say nothing, as they have not yet been opened up, which in most cases will be an expensive matter; and if the shareholders are not prepared to meet the cost they had better drop them at once and join in developing those that give a better prospect of an early return, and so attract the attention of the outside world and obtain assistance in working these more complicated claims.

PARKER'S FIND.—Another rich deposit of gold was found about forty miles to the South of Southern Cross, and named after its discoverer, Mr. Parker, who has taken up an area on which there are four auriferous reefs, one being particularly rich. Several holes have been made in the cap, but nothing has yet been done to test these reefs, with the exception of a shaft that is being sunk on an ironstone hill, where some gold was found in a small mullocky "horse" at the surface.

Judging by the richness and extent of the quartz this claim should be tested as quickly as possible, as it will, most likely, prove to be very valuable. There are several other claims on Parker's line, where gold shows freely in the stone, but scarcely any work has been done on them as yet, and in some cases, where the reefs have been cut in depth, they are too small to pay for working. Owing to the great scarcity of water last summer, prospectors had very little chance in this part of the field of developing their claims.

The Uphill's claim is situated on another line of gold-bearing reef, five miles to the South-West of Parker's, and is being tested in a thoroughly systematic and satisfactory manner; first by a vertical shaft of eight feet, then by an under-lay of thirty-eight feet in the reef, and then it is proposed to run a level along the course of the lode to ascertain how far the gold-bearing stone extends. This lode has the best defined walls on the field, is five feet in width, three of which are stone, and the whole is rich in gold. This will probably prove a very rich little mine.

On the Yilgarn claim the reef, having been thrown out by a cross-course, has not yet been struck, although very rich stone has been picked up on the surface.

There are several other claims on this line, but they are not yet sufficiently developed for a report to be made on them. There is said to be another discovery twenty-six miles further to the South, which I consider a misfortune for the present rather than otherwise, for already more land has been taken up than could be worked by the united mining population of Western Australia.

In conclusion, I would repeat that I consider the future of the field depends to a very great extent upon the principal claims I have mentioned being properly

handled at the start. I do not say that they will remain the best things on the field, for it is highly probable that still finer reefs will be discovered when the flats and the lake beds are prospected, and indeed some of the claims that are not now highly estimated may come to the front, whilst others, now so showy, may sink into oblivion.

It is almost certain that large alluvial patches will be found to exist in the deep ground of the lakes, as with so many rich reefs around them it is most improbable that such a deposit as was found below the Central's is a solitary occurrence. Up to the present there have been so few alluvial diggers of experience on the fields that no prospecting worthy of mention has been done in this direction.

Not the slightest doubt exists in my mind of the richness and permanence, and of the ultimate success of these fields, for they have been proved to extend over an area of eighty miles in length; and they will in all probability be found to continue to the South coast. But I consider that it is essential that a railway should be constructed connecting the fields with the settled districts, for no real progress can be made until there is a cheap and rapid mode of transit established, not only for machinery and stores, but also to give visitors an easy access to the mines, for possessors of capital are not likely to undertake the journey by road. I cannot see that the proposed telegraph line will be of any real assistance, while the railway would not only be so, but would form the first section of the great transcontinental line.

The water question has always been, and will always be, a most serious one, but it will, I believe, be from too great an underground supply that the mines will suffer most. Artesian water will never be obtained in the goldfield area, and boring for it is only a waste of money. Large reservoirs should be constructed in the beds of those lakes that are fresh, or nearly so, in which large quantities of water might be stored, and should this become salt towards the end of the season, that remaining could easily be pumped out before the rain commenced.

The water in the mines will, I believe, become fresher after heavy pumping, so that there need be no fear of the future of the field being imperilled on account of the scarcity of water.

EXAMINATION OF THE COUNTRY TO THE NORTH OF PERTH CONTINUED, WITH ESPECIAL REFERENCE TO THE GREAT CARBONIFEROUS FORMATION.

Report issued December, 1889.

As I have twice already in my Reports described the country between Perth and the Irwin River, I do not propose to say any more about it now, although I had again to cross it on my way to the Irwin coal seam.

THE IRWIN COALFIELD.—On revisiting the field I found, that although a good deal of money had been spent in one way and another, very little work of any importance had been done.

Poor shaley seams, similar to those discovered by Messrs. Bell & Elliot which out-cropped in the cliff, on the North branch just outside the Coalfield Reserve, have also been found on the Reserve and for a considerable distance up the branch on which Gregory was supposed to have made his discovery; but up to the present no work of any consequence has been carried on, owing to the immense body of salt water encountered.

Some tons of this coal have been sent for trial on the coasting steamers and trains, and at the time of my visit it was used on a trial trip from Geraldton to Fremantle, but as it was found to be rather inferior in every way to the New South Wales coal it certainly will not be worth working, especially as the amount of coal consumed in this Colony is so small that it would never pay to work a mine for our own consumption, and the quality is so inferior that it would not find any market abroad.

The suggestion that I made on my first visit that a shaft should be sunk to test this field, was, it seems, misunderstood by those at work (who were lead and copper miners) and taken to mean that they should follow the seam or bed down its dip, which they accordingly did for 150 feet; but finding so little improvement in quality, they abandoned this first and uppermost seam and set to work on another, some distance down the river, which is certainly of a better quality but still not sufficiently good to be worth working.

I was able to trace the outcrop of these seams in the branches of this river for a distance, from North to South, of forty miles, but in no instance could I find any indication of a good coal, which has caused me to rather lose faith in this field, for, the formation having a considerable dip, a perfect succession of the beds is seen in each of the branches running East and West, and all over this area the beds are all of this same poor quality, although associated with the same shales and sandstones in which true carboniferous fossils occur. If there were superior beds underlying these, they would outcrop in the beds of the streams further to the West, but nothing of the kind appears, but, instead, a flaggy sandstone and a large series of clay-slates and clay-stone beds, containing impressions of carboniferous plants, occupy their place.

This question will soon be set at rest, for the companies have combined to carry on boring operations to test the Carboniferous series in depth.

The quantity of salt water met with in these rocks, and the extent of sandy country that has to be crossed to reach the nearest port, are great drawbacks to the development of this field.

The coal itself occurs in thin seams mixed with coaly shale; it is dirty to the touch, and contains so much water that it falls to pieces on exposure to the atmosphere.

Two assays made in London gave the following results: No. 1 was by Mr. Harland, and No. 2 by Mr. Wingham.

	No. 1.			No. 2.		
Water	17.04	...	...	12.4
Volatile matter	28.61	...	...	32.2
Fixed Carbon	41.29	...	...	43.5
Ash	13.06	...	...	11.9
			<hr/> 100	...	...	<hr/>100
Sulphur	0.83 per cent.

The large amount of ash may in part be due to extraneous earthy matter. The coal cannot be utilised for gas making, as it does not cake, and the coke formed, being in powder, is valueless; but, as before mentioned, the coal can be used for steam boilers and household purposes, and for those metallurgical operations in which a particularly high temperature is not required.

Continuing my exploration of the North branch of the Irwin to Badgerer I found in the cliff sections shales, sandstones, and clays, but neither coal seams nor any signs of carboniferous fossils, but from the lithological similarity and conformity to the rocks of that age, I am inclined to class them in this series,

From this point, however, the country changes entirely, the old crystalline rocks, containing quartz veins, and ferruginous lodes stained with copper, outcrop and continue on the surface to the North, and to the head of the river, where they are capped by clays and gravels. Between the Irwin and the Greenough Rivers there is an elevated table-land covered by a sand plain, and extending from the coast to the Herschel Range. This low line of hills runs North from the head of the Irwin by Mullewah to the Greenough River; they consist of schistose rocks, and rise but very slightly above the table-land. In the deep gullies small quantities of gold have been found, and also very nice, though small, lodes of copper, but nothing up to the present rich enough to pay for working, and it would require something very rich to do that in this almost inaccessible position, there being thirty miles of heavy sand between it and the coast. Whenever a line of railway to the Murchison country is constructed this tract will be well worth prospecting.

In the valley of the Greenough, below Tallering Peak, the same non-fossiliferous beds, which I classed as Carboniferous in the Upper Irwin, again make their appearance, forming high and almost vertical cliffs, and in places flat-topped hills; but there are no sections to be seen in the river bed, at the level at which the coal seams should be; and so I cannot say whether the coal extends thus far, though it seems probable, for we find salt springs breaking out here like those occurring on the Irwin, where coal is found.

Between the Greenough and Murchison we again encounter the elevated sandy table-land, which here, however, is towards the coast, broken by numerous streams, in the beds of which sections of the old rocks are exposed. These contain the lodes of copper and lead that have so long been worked in the Northampton district.

This line of mineral bearing country extends in a Northerly direction from Geraldton as far as the Geraldine on the Murchison River, and it seems to form the Western side of the basin in which the Carboniferous rocks were deposited, for between this line and the coast nothing but Mesozoic rocks are found. Whether the coal measures may to any extent underlie them we cannot say; but, wherever the rivers have cut through the newer strata, only crystalline rocks are to be seen, even as far West as the coast.

On the Murchison River, just above this outcrop of mineral bearing country, the Carboniferous rocks again made their appearance, but here again, as on the Greenough, there are no good sections and no fossils, though the springs break out in the same manner as on that river and on the Irwin. This is evidently due to the fact that these nearly horizontally bedded Carboniferous rocks lie upon an impervious bed, which causes the water, percolating through the sandstones from the higher country to the Eastward, to come to the surface.

This formation continues up the Murchison as far as the great bend, where the country opens out into what may be called the characteristic Murchison country, namely, large alluvial plains with low ranges of schistose rocks, containing quartz reefs, the ranges being mostly flat-topped and capped with a ferruginous sandstone, and with here and there bold granite hills that are evidently a Northern continuation of the line of intrusive rocks that can be traced down to the South coast. In several places between this great bend and Milly Milly there are patches of very promising mineral country, that I consider should be prospected.

From Milly Milly on the Murchison, to Mount Clair on the Gascoyne, the country is rugged and hilly, the surface being strewn with quartz, and numerous reefs of this are visible. Similar country continues down the Gascoyne, to its junction with Darie Creek, where the carboniferous rocks again re-appear, and where there is a larger development of this series exposed than anywhere else in the Colony. The crystalline limestone, full of fossils, extends from the Woromoll

River to the Gascoyne, and on up the Lyons, forming the flat-topped Kennedy Range, but here it is so horizontally bedded that the under-lying beds are rarely exposed, and it is only in well sections that shales and sandstones can be seen. In some of these shales fish scales are found, and these were among some of the first fossils to be identified as Carboniferous.

No coal seams have as yet been discovered in this district, for only the limestones are visible, and no boring has been attempted, and so it is impossible to say whether or no they exist here.

The Carboniferous system has now been proved beyond a doubt to extend for a distance of three hundred miles to the north of the Irwin, so it will be very strange if some better seams of coal, than those found in its mouth, be not found when the district is properly tested; but there being little money in the Colony that can be spent on experimental bores just now, it must wait for better times, or for enterprise from outside.

The finding of a coal seam on the Gascoyne would be a good thing, as Sharks Bay, one of the few really good natural harbors of this country, is situated at its mouth.

From the Lyons River down to the mouth of the Gascoyne, sandy country, similar to that above classed as Mesozoic, is crossed. In some portions, however, plant remains have been found proving them to be of more recent origin.

Along the coast at Sharks Bay a large deposit of Tertiary limestone, containing fossils, occurs.