

1891.

WESTERN AUSTRALIA.

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# ANNUAL GENERAL REPORT

FOR THE YEAR

1890,

BY

HARRY PAGE WOODWARD,

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

GOVERNMENT GEOLOGIST.

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PERTH:

BY AUTHORITY: RICHARD PETHER, GOVERNMENT PRINTER.

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# GEOGRAPHICAL CONFIGURATION

## WESTERN AUSTRALIA.

*From the Government Geologist to the Honorable the Commissioner of Crown Lands.*

SIR,—

I have the honor, herewith, to forward you my Annual General Report for the Year 1890.

I have, &c.,

HARRY PAGE WOODWARD,

20-4-91.

Government Geologist.

### General Report of Work done during the Year 1890.

In January I received instructions to proceed to the Yilgarn Goldfields to report on the advisability of continuing boring operations for artesian water. This, with the preparation of a report, occupied me till the end of February.

In March I was engaged in arranging the geological collection which was being transferred from Fremantle to Perth; also in the preparation of a general report of the work done during the years 1888 and 1889.

In April I was instructed to prepare a collection of minerals and ores for the Mining and Metallurgical Exhibition which was to be held in London. This work, and the preparation of a pamphlet descriptive of the mineral resources of the Colony, occupied my time until the end of May.

In June I started for the North, proceeding to Geraldton by boat, after which I went overland, up the Murchison, by Yuin, Berringarra, Milly Milly, Mt. Nairn, the Wooramel River, Dairie Creek, the Gascoyne, the Wyndham, the Arthur, the Lyons, the Alma, the Henry, to the Ashburton, where I inspected the diggings; and returned down the river, and travelled North by the Cane, the Robe, the Fortescue, the Nicol to Roebourne, where I reported upon the Ashburton Goldfield, after which I travelled Eastward to Mallina, Egina, Pilbarra, and the Nullagine; then returned to Roebourne, and came South by sea, arriving in Perth at the end of November, when I was engaged in the preparation of a report on the Pilbarra Goldfield until the end of the year.



## GEOGRAPHICAL CONFIGURATION.

### GENERAL FEATURES OF THE COUNTRY BETWEEN GERALDTON AND THE DEGREY RIVER.

**COAST LINE.**—To the Northward of Geraldton, for a distance of 200 miles, the coast line is almost unbroken, presenting a low line of limestone cliffs, with no indentations or land-marks after the Morsby's Flat-topped Range, near Geraldton, is lost sight of. Near Steep Point, at the Southern entrance to Sharks Bay, there are some spouting rocks which present a grand appearance when a good swell is breaking on the coast.

At Sharks Bay there is the most broken piece of coast line in the whole Colony, but here, as further South, the coast is low and presents no bold features.

From Carnarvon, at the mouth of the Gascoyne, and to the Northward, the coast is low, consisting of low sandy dunes with salt swamps behind them.

Around North-west Cape and Exmouth Gulf are low vertical cliffs forming the escarpment of the table-land which lies inland. After passing the mouth of the Ashburton the coast runs in a N.E. direction as far as the Fortescue, and is low and swampy with sand dunes.

From this point it runs E. and W. for 200 miles, and is a good deal broken, presenting a series of bold headlands, with inlets and mangrove swamps, backed by low alluvial plains.

**CAPIES.**—The principal capes along this coast are : Steep Point, on the South side of Epiheux or False Entrance of Sharks Bay ; Cape Peron, at the North end of Peron's Peninsula ; Cape Inscription, at the North end of Dirk Hartog's Island ; Cape Cuvier, about 60 miles N. of the mouth of the Gascoyne ; Cape Farquhar, about 40 miles further North ; Point Cloates, 50 miles South of North-west Cape ; North-west Cape at the North end of a peninsula to the Westward of Exmouth Gulf ; Cape Preston, 50 miles West of Nicol Bay ; Cape Thouin, 80 miles East of Roebourne ; and Point Larrey, near the mouth of the DeGrey.

**ISLANDS.**—There are a good many islands along this section of the coast. The most important are : the Guano Islands, the Abrolhos or Houtman's Rocks (off Champion Bay), Dirk Hartog's, Dorre, and Bernier Islands form Sharks Bay ; Muiron Island, at the mouth of Exmouth Gulf. From this point to the North-east a belt of islands follow the coast, the largest of which are Barrow and Monte Bello Islands, which lie respectively 30 and 50 miles off the coast, at the mouth of the Fortescue. Dampier's Archipelago is off Nicol Bay, Depuch Island 50 miles further East close to the coast, and Bedout Island 25 miles off the mouth of the DeGrey.

**BAYS AND GULFS.**—Champion Bay, at Geraldton ; Gantheaume Bay, at the mouth of the Murchison ; Sharks Bay, between Peron's Peninsula, Dirk Hartog's Island, and the mouth of the Gascoyne River ; Exmouth Gulf, inside North-west Cape ; and Nicol Bay, by Cossack and Roebourne.

**CHANNELS.**—Geelvink Channel, between Houtman's Rocks and the mainland ; Epiheux (or False Entrance), between Dirk Hartog's Island and Steep Point ; Naturaliste Channel, between Dirk Hartog's Island and Dorre Island ; Geographe Channel, between Bernier Island and the mainland.

**RIVERS.**—The Greenough, about 200 miles in length, flowing in a S.W. direction, and discharging itself a little South of Champion Bay ; the Murchison, about 500 miles long, flows generally to the S.W., discharging itself into Gantheaume Bay, its main tributaries being the Sanford and Impey ; the Wooramel

is about 200 miles in length, and flows in a Westerly direction into Hamelin Pool, Sharks Bay. The Gascoyne is about 500 miles in length, and flows mostly in a Westerly direction into the North part of Sharks Bay, its main tributary on the North is the Lyons, which is 250 miles in length. The Lyndon and Manilya are each about 150 miles in length, discharging themselves, after flowing in a Westerly direction, into large salt swamps or lakes, about 80 miles to the Northward of the mouth of the Gascoyne. The Ashburton is about 500 miles in length, flowing mostly in a North-west direction, discharging itself into the ocean about 60 miles West of North-west Cape; its main tributaries are the Hardy and Duck Creek on the North, and the Henry on the South. The Fortescue River is about 200 miles in length, flowing in a Westerly direction, emptying itself into the sea at a point about 30 miles South-east of Barrow Island. The Yule River is about 150 miles in length, flowing first West and then turning to the North, discharging itself on the North-west coast by two mouths, one on either side of Cape Thouin. The DeGrey is about 250 miles in length, but the upper part of it has been differently named by the early explorers; it flows in a North and North-west direction, discharging itself into mangrove swamps on the South-west side of Point Larrey; the main branch on the Eastern side is called the Oakover, but should be called correctly the DeGrey, as it is the main river; on the Southern side are the Strelley or Turner, the Western Shaw or Coongan, the Eastern Shaw or Emu Creek, and the Nullagine.

**MOUNTAINS.**—There are no very high mountain ranges in this part of the Colony, for although some of the peaks are said to rise to a considerable elevation above the sea, it must be remembered no heights have been accurately measured, and that they rise from an elevated table-land often as much as 2,000 feet above the sea-level.

Tallering Peak is about 100 miles from the coast, on the Greenough River; it is a bold mass of crystalline rocks rising about 1,000 feet above the plain. On the Murchison a series of isolated peaks are met with, of no great elevation, but they are striking land-marks, as they rise abruptly from the alluvial plains; the most important of these are Mt. Murchison, Narryer, Dugal, Nairn, Mathew, Hall, and Gould. At the head of the Impey River is the Weld Range, and at the head of the Murchison are the Robinson, Kimberley, and Glengarry Ranges.

On the Gascoyne are Mounts Dalgety, Steere, James, Packford, Gascoyne, Clere, Egerton, and Labouchere. The Kennedy Range is at the junction of the Lyons and Gascoyne, and higher up the former river are Mounts Thomson, Agamemnon, and Augustus.

Between the Lyons and the Ashburton are the Barlee and Capricorn Ranges. On the Ashburton are Mounts Mary, Alexander, Murray, Price, Danvers, Clements, Edith, and Florrie; and on the Duck Creek and Hardy, Mounts Stuart, De Courcey, Wall, Turner, Brockman, Lionel, Samson, Victor, and Bruce.

On the South side of the Fortescue is the Hamersley Range with Mounts Pyrtou and Margaret, whilst on the North side are Mounts Herbert, Montagu, Leal, Richthorpe, and Billroth.

Along the North coast are Mounts Sholl, Wellard, Oscar, Constantine, Negri, Langenbeck, &c.

**LAND SURFACE.**—The country generally consists of open plains or table-lands, broken by large alluvial river valleys in the Southern portion, and deep gorges in the Northern. In the Southern portion it extends to the coast, where it ends in almost vertical cliffs, but in the Northern portion it terminates about 30 miles from the coast, presenting a bold escarpment, between which and the sea are large alluvial plains.

The whole of this belt of country may be considered the pastoral area of the Colony. Although up to present it has produced nothing to compare with

the great pastoral districts of the Eastern Colonies, it will before long; and when it is considered that most of this country has been settled by persons without money, on a very small scale, with any sort of stock that could be obtained in the Colony, and worked by native labour, it proves conclusively that the country must be good to pay working expenses, rent of land, and interest on money borrowed.

**WATER SUPPLY.**—It is a wonderfully well-watered country, as all the land used for pastoral purposes has been selected on account of the surface water, or, the next thing to it, water at a few feet from the surface. There are no wells worth speaking of, the deepest, a little over 100ft., was sunk by the Government on the Egina Goldfield; for, as a rule, if water is not obtained before rock is struck, the well is abandoned.

**RAINFALL.**—The rainfall as a whole is good. The Murchison depends principally upon the winter rains. The Gascoyne has both summer and winter rains, whilst North of this they depend almost entirely upon summer rains; but on the strip along the North coast the rainfall is most uncertain, and the only thing that seems to make the rivers run is a cyclonic storm, called locally a "willy-willy," which, although doing a great deal of harm to property over which it passes, supplies it with water for a season or two.

**CLIMATE.**—On the North-West coast the climate is very hot even in winter, with now and then a short period of cool weather.

South of this, inland, it is extremely hot during the summer, but during the winter the weather is very pleasant, whilst along the coast, where the sea breeze blows, the climate is all that can be desired all the year round.

**TIDE.**—On the North-West coast there is a remarkable rise and fall of tide, which in places exceeds 30ft., whilst at the South, near Geraldton, the rise and fall is scarcely perceptible.

## GEOGNOSY.

### A GENERAL DESCRIPTION OF THE VICTORIA, MURCHISON, GASCOYNE, ASHBURTON, FORTESCUE, ROEBOURNE, AND DEGREY DISTRICTS.

Geraldton is a town situated a little over 200 miles North of Perth, on the coast in Champion Bay, a little to the North of the mouth of the Greenough River.

About 30 miles off this coast lie the Abrolhos guano islands; they are composed of low tertiary limestone rock, on which large numbers of sea fowl nest, but owing to the considerable rainfall on this coast the guano is poor in quality, having lost most of its ammonia and soluble salts; however, as there are very large deposits of phosphate of lime, it is being worked very successfully.

Immediately surrounding the town of Geraldton are high steep sand ridges, which have been formed by the action of the wind, and are a great source of trouble, for, when strong winds blow from one quarter for a considerable time, quantities of the sand are shifted. This is being overcome by bushing them up, when it is found that vegetation thus protected will spring up, and when once fairly established prevents these dunes from shifting.

A good supply of water fit for brewing and making aerated waters is found at the base of these hills at no great depth from the surface, but the water in the town nearer the coast is much too hard, and sometimes even brackish.

At the back of these sand hills, or to the Eastward, are low coastal limestone hills, similar to those met with all down this coast.

To the Northward, across the valley of the Chapman River, and the back flats of the Greenough, is a broken table-land, of Mesozoic age, presenting a series of bold flat-topped hills, most of which are marquee shaped, but here and there isolated peaks are also seen.

To the Eastward of Geraldton are the two fine alluvial flats of the Greenough River. They are very low, and when very heavy rains fall in the interior they are subjected to floods, when fences, houses and stock are washed away. These flats are bounded on the N.W. by the broken table-land, the South by the low coastal limestone ridges, whilst they are separated from one another by a low sandy ridge. The Greenough River itself flows down the front flat, discharging itself into the sea a little to the Southward of Geraldton, but it is highly probable that it formerly flowed down the back flat, when it would discharge itself to the Northward of Geraldton, somewhere about the mouth of the Chapman River.

For 60 miles to the Northward (as far as the Murchison River), amongst the broken table-land, where the rivers and streams have cut through the overlying Mesozoic formations, the crystalline and Metamorphic rocks are exposed, with numerous intruded dykes and rich mineral veins.

Following the Greenough up its course to the N.E., it leaves the flats and flows in a deep channel through high sand plain country, the underlying rocks of which, exposed in the cliffs beside the river bed, are white and colored soft shaley sandstones and dark-colored argillaceous shales, very similar in character to the Carboniferous series exposed in the bed of the Irwin River, but the fossiliferous limestones are not here met with.

About 60 miles from the coast this formation gives place to the old crystalline rocks, and the river flows close under the South side of the bold Talling Peak (which is the only hill in this district), so on in a more easterly direction to Yuin.

Here the valley opens out into the fine alluvial flats of the Murchison District, with here and there low ridges of Metamorphic rocks, often capped with more recent deposits of ferruginous sandstones.

Further to the Eastward the river branches out over these plains, taking its rise near the head of the Sandford (a branch of the Murchison), where several bold granite hills rise abruptly out of the plains. This belt of granite dykes extends in a Southerly direction as far as the South coast, and it is immediately to the Eastward of this that a line of Metamorphic rocks, with very rich auriferous reefs, are met with here and there along its entire length.

To the Eastward of this intruded granite belt, the small streams flow in the opposite direction, emptying themselves into the large salt lakes or clay-pans of the interior, which sometimes overflow into the rivers which flow to the coast, but as they more generally have no outlet the water evaporates, leaving after each rain a fresh deposit of salt to add to that already there. One of these salt pans, called Austin's Lake, is situated here, but it must seem to everyone a pity they were ever called lakes, as it is so misleading to strangers; but many other physical features are the same. For instance, the *rivers* are dry flood-water channels, the *inlets* have no outlets, except after floods, the *mountains* are simply small hills, and the *ranges* ridges.

All the interior, as far as known, consists of an elevated sandy table-land (resulting from the weathering of the ferruginous sandstone beds which are here and there exposed, capping isolated hill-ridges), with large alluvial flats around



the salt clay-pans, and here and there low ridges of Metamorphic country, but occasionally, where these rocks are of a harder nature, they stand up as bold range masses, but, with the exception of the information obtained from the few explorers who have crossed the Continent, very little is at present known about it.

The next river, further to the Northward, is the Murchison, which discharges itself into the sea at Gantheaume Bay, which is about 60 miles North of Geraldton.

In the first 30 miles of its course from the coast, the river forms a large bend, first to the North and then South, through a broken Mesozoic table-land (which is the Northern extension of the flat-topped hills about Northampton); and in the bed of the river, in places, the shales similar to those of the Irwin and Greenough are met with, but as yet no fossils have been found by which to determine their age.

In the bed of the river, at the Geraldine Mine, about 30 miles from the coast, Metamorphic rocks with rich lead lodes outcrop; these latter were worked many years ago, and a large deserted village with fine mine buildings and smelting works are still standing.

To the Northward of the mine a high sandy table-land is seen, whilst just above this outcrop of mineral bearing country, the Carboniferous rocks again make their appearance; but here again, as on the Greenough, there are no good sections and no fossils, though salt 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 should be prospected.

The Sandford and Impey, which are the two main branches, flow from the East, passing over very similar country to the river itself, namely, large alluvial flats with here and there bold range masses and peaks of Metamorphic and granitic rock rising abruptly from the plain, and low Metamorphic ridges capped by horizontally bedded ferruginous sandstone.

The Murchison rises in the edge of the broken table-land amongst crystalline rocks of the Robinson, Kimberley, and Glengarry Ranges, 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 of the upper 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.

This river, although subjected to yearly floods of greater or less magnitude in its upper courses, where the pools are fresh or only slightly brackish, very rarely runs throughout its entire length, the flood waters being lost on the large alluvial plains. When, however, these floods do reach the sea they are not altogether a blessing to the settlers on the Lower Murchison, for they carry all the salt water

which has accumulated in the large pools in the middle courses of the river down, spoiling in that part all the fresh-water pools which are filled by the coastal rains.

The large alluvial plains of the Murchison are celebrated for their magnificent water supply, for throughout this district it is possible to obtain water at a very slight depth. This is being now taken advantage of by the sheep farmers, who are opening their old wells out into tanks, with sides at such an angle that the sheep can walk down and water themselves.

This water supply is generally found under a magnesian deposit (locally called opaline), which has evidently been formed by the evaporation of the water, which is slightly charged with this mineral, and, as it has cemented the sand and shingle together, it is very hard stuff to work through.

Flowing in an Easterly and Westerly direction, in a straight line, from near the upper part of the Murchison, is a river which at present is scarcely known, it being about the only large river in the Colony of which the survey has not yet been published. This is to be accounted for by the fact that it flows through very poor country and is off the main North track, which passes almost round its head; this is the Wooramel River, which flows into Hamelin Pool, Sharks Bay. It is of considerable interest geologically, as the series of rocks are better exposed in its bed than are met with in any other river.

Near its mouth, after leaving the low coastal limestone, it flows through a sandy table-land at the base of which are the Tertiary rocks with fossils, whilst further East the Mesozoic series are crossed, and so on to the Carboniferous sandstone, shales and limestone with fossils, while further East the crystalline rocks with quartz reefs outcrop.

This river, in its upper courses, flows over good sized alluvial flats with outcrops of crystalline rocks here and there, often capped by ferruginous sandstone, with here and there patches of earthy limestone, but below where it cuts the Carboniferous rocks it flows in a large deep valley with cliffs on either side, on the top of which is a sandy table-land.

Carnarvon is a township situated at the mouth of the Gascoyne River at the North of Sharks Bay, which bay forms one of the striking features of the coast, which, as a rule, is singularly unindented or broken. It is a good harbour, protected from the West and North-West at its entrance by Bernier and Dorre Islands, the main entrances being Geographe Channel at the North, between Bernier Island and the mainland, Naturaliste Channel in the middle, between Dorre and Dirk Hartog's Island; whilst at the South there is Epiheux or False Entrance, but here the water is too shallow to allow anything but small coasting boats to enter.

To the South Sharks Bay is split up into two main gulfs by Peron's Peninsula; the one to the West, or at the back of Dirk Hartog's Island, being called in the Northern part Denham Sound, but further South Freycinet Estuary, whilst the one on the Eastern side of Peron's Peninsula is called Hamelin Pool. The islands here and down the coast to the mouth of the Murchison are mostly low coastal limestones of very recent age, the fossils from which embrace most of the existing types.

Between the Wooramel and the Gascoyne there is a belt of high stony table-land, the Western portion of which is called the Byro Plains and the Eastern the McAdam Plains. The stones and boulders strewn here on the surface in the Western portion are derived from boulder beds of the Carboniferous or Devonian series, but those on the upper or Eastern portion are derived direct from the crystalline rock and quartz reefs.

The Gascoyne River, for the first 20 miles from the coast, flows over alluvial or estuarine deposits of fine loam and brick earth, and for the next 50 miles in an Easterly direction through a sandy table-land of Tertiary age. For the next 20 miles it passes in almost a gorge through the bold Kennedy Range,

where Mesozoic rocks, consisting of sandstone and limestone, are met with. In the next 50 miles, where the river is joined by its main tributaries—the Lyons, Arthur, Wyndham, Dairie and Dalgety—the Carboniferous formation outcrops in a series of flat-topped hills of limestone, shale, sandstone, conglomerates, gypsum, and clay beds, often very rich in fossils, but up to the present no sign of coal has been found. Just above this the river makes a sudden bend, opening out into fine alluvial and stony flats, with here and there bold ranges of crystalline rocks rising suddenly from the plains. This great bend, which first turns North and then South, forms almost two sides of an equilateral triangle, the base of which is 50 miles. In this part of its course the river is of great width, flowing, when in flood, in a large sandy bed in which fresh water can be obtained nearly anywhere at a few feet, but all the pools appear to be filling up with sand.

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 down 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.

The Lyons River is the main tributary of the Gascoyne, joining it on the Northern side just to the Eastward of the Kennedy Range. From this point its course is nearly due North for a distance of 100 miles over open alluvial plains, with the bold Kennedy Range to the Westward, and low flat-topped hills of limestone and shale, of Carboniferous age, to the Eastward.

At Mt. Thomson, where the crystalline rocks outcrop, it makes a sudden turn to the Eastward, flowing over these rocks and granite for 100 miles.

This river takes its rise between the Teano Range, Mt. Labouchere, and the great flat-topped range that forms the water-parting between those rivers that flow in a North-Westerly from those flowing 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 to an elevation of 3,500ft. above sea-level.

The Minilya and Lyndon rivers take their rise in the Carboniferous country a little to the Westward of Mt. Thomson, which is situated at the great bend of the Lyons River. They are about 100 miles in length, flowing over the Carboniferous, Mesozoic, and Tertiary formations, and discharging themselves into a large swamp separated from the sea by a low coastal sandstone ridge of Tertiary age. This swamp overflows at the North of the mouth of the Gascoyne River, also about 100 miles further North a little to the Northward of Cape Farquhar.

From this point North, around North-West Cape and Exmouth Gulf and the coast as far as the mouth of the Ashburton River, there are low limestone cliffs facing the sea, whilst inland, on the top of these, for about 100 miles, is a sandy table-land, probably of Mesozoic age.

To the Eastward of this, on the Henry and all the country between the Lyons and Ashburton Rivers, is a high crystalline limestone table-land, of Palæozoic age (Devonian?), with here and there bold ranges, as the Barlee Range, where the rivers have cut large valleys and deep gorges through these almost horizontally bedded rocks.

The Asburton River is about 500 miles in length, discharging its waters on the N.W. coast, about 60 miles West of the North-West Cape.

For the first 50 miles of its course it runs in a nearly South direction through a low broken table-land country, of Mesozoic age, then striking more to the Eastward

for the next 50 miles, passing through a belt of Palæozoic rocks to its junction with the Henry, Duck Creek, and Hardy, where it spreads out into fine alluvial plains, often 20 or 30 miles in extent, with here and there low ridges of clay slate and quartz, with bold range masses of harder rock standing up above the flat here and there.

For the next 150 miles the river continues its course to the South-East, with rough slaty country to the North and South, closing, in some places, upon the river, which here flows in a deep channel, almost a gorge, for a few miles, then opens out again into larger alluvial flats to the Northward. To the South, at 15 to 20 miles from the river, are flat-topped ranges of magnesian limestone with many springs where the creeks have cut deep channels into these rocks.

This belt of country has proved very rich in gold; it is probably of Silurian age, from its similarity to the gold-bearing country of Victoria, but this is uncertain at present. This river takes its rise far away in the sandy table-land of the interior, but very little is at present known of this country. Although of great length, this river flows in a comparatively small but deep channel in which large water-holes are met with, which are the mainstay of this country.

The Henry, one of the main tributaries of the Ashburton, takes its rise about 100 miles to the South, near the great bend of the Lyons, in the Barlee Ranges.

In the upper part of its course it flows over a large plain with here and there exposures of granite and crystalline rocks, but, on approaching the point where the range closes in, it flows in a deep gorge between cliffs of crystalline limestone, from which many heavy springs break out 30 miles above its junction with the Ashburton; below this it flows in a deep channel with large alluvial plains on either side, and here and there outcrops of rock or flat-topped limestone hills. Duck Creek and the Hardy River join the Ashburton a little higher up on the North side; they flow near their junctions over low alluvial plains, with here and there ranges standing up from them in their lower courses, but, higher up, flowing through rough slaty and granite country, taking their rise in the great table-land at the head of the Fortescue River.

Between the Ashburton and the Fortescue is a high Palæozoic table-land near the Robe and Cane Rivers, which has been cut away into flat-topped hills which rise out of low alluvial and stony plains. In this table-land country, and also on the alluvial plains, many great masses of amygdaloid are met with forming bold rough barren hills of a red or black color. The Fortescue is about 200 miles in length, taking its rise in the great Palæozoic table-land and flowing in a course nearly due West, in a large alluvial flat, between the Hamersley Range to the South and high table-land country to the North; the creeks which flow from this are fed by springs, which cause this river to be always trickling.

At about 30 miles from the coast it leaves the table-land, flowing across low alluvial plains in a Northerly direction, discharging its water into mangrove swamps a little South of Cape Preston.

From this point along the coast, for a distance of about 300 miles, the rivers flow in a Northerly direction, taking their rise in the table-land close to the North side of the Fortescue River.

With the exception of the DeGrey and Yule, which take their rise to the Eastward of the head of the Fortescue, these rivers are not more than 100 miles in length, and present generally the same character. They are fed by springs in the Palæozoic table-land to the South, through which they flow in deep gorges in their upper courses. Their middle courses are through slaty and Metamorphic country with intruded masses of granite and amygdaloid, some of the highest hills being capped with horizontally bedded quartzites and limestones, detached portions of the great table-land. In this country the valleys often open out into large alluvial flats of considerable size, which again close in as the streams pass



in narrow gorges through the hard belt of crystalline rocks, which here lie at a distance of from 10 to 50 miles from the coast, forming the edge of the coastal plains over which the rivers flow in their lower courses. The large alluvial flats are broken here and there by low ridges of Metamorphic rock and quartz reefs or bold masses of amygdaloid, which form bare rough hills, the whole being fringed by mangrove swamps, except where these intruded masses occur on the coast.

On this alluvial flat many of these rivers split into two channels, forming islands by uniting again or by flowing into the sea at two points, often at a considerable distance from each other. All along this coast the bold headlands and islands are of highly Metamorphic or trap-rocks, rising often to a considerable elevation above the sea and the alluvial plains to their Southward.

To the Eastward of the DeGrey is Warburton's great sandy desert, covered with parallel lines of red sand-hills; from this country there are no rivers flowing towards the coast, so if all the water does not soak away into the sand what drainage there is must be into lakes in the interior.

## GEOLOGY.

This tract of country would be very interesting to examine in detail, as it is the only portion of this Colony where a fine series of formations are exposed, but unfortunately time at present does not permit of this; therefore this geological description must be taken as simply a sketch for the purpose of giving a general idea to prospectors where the most likely tracts of mineral country are, and if this end is attained it is all one can hope for, with such a limited staff and such a large field.

The formations which do occur in this portion of the Colony are as follows:—

### SEDIMENTARY ROCKS.

Palaeozoic or Mesozoic or Primary.	Cenozoic.	Quaternary.	Recent (Holocene).	{ Alluvium, River Gravels and Estuarine deposits, Sand Dunes, etc.
			Pleistocene.	{ Ancient River Gravels, etc. Lower Estuarine deposits, shelly limestones and sandstones of the coast.
		Tertiary.	Pliocene?	Ferruginous sandstones and variegated clays.
			Eocene?	{ Coralline and chalky limestones with flints, calcareous and ferruginous sandstones and grits.
	Secondary.	Cretaceous?		{ Chalky limestones with flints, sand, ferruginous sandstones, limestones, clays, and mudstones.
				{ <i>Oolites</i> .—Oolitic limestone, clay ironstone, ferruginous sandstone, grits, and conglomerates.
		Jurassic.		{ <i>Lias</i> .—Ferruginous and variegated limestones, clays, and ironstones.
				{ Sandstones, grits, conglomerates and ironstone, magnesian limestones, mudstones, micaceous clays and shales, with iron-pyrites, gypsum, and coal-seams.
		Primary.	Lower Carboniferous.	
	Devonian.		{ Clay-slate, limestones, marble, dolomite, sandstones, quartzites, and conglomerates.	
	Silurian (?) and Metamorphic.			

Azoic.	{	Archaean (Meta- morphie).	{	Slates, schists, quartzite, gneiss, granitoid, and garnet rocks.
				IGNEOUS ROCKS.
		Volcanic.	{	Basalt, Dolerite, amygdaloid.
		Plutonic.	{	Felstone, diorite (greenstone), syenite, granite, porphyry.

#### RECENT AND TERTIARY ROCKS.

The alluvium is met with, forming the large river valleys and flats throughout this district, also along the North-West coast.

The river gravels are found in the beds of all the large rivers, which are often as much as a mile wide. Estuary deposits occur at the mouths of the Gascoyne, Manilya, and Lyndon Rivers.

Sand dunes are seen along the coast at Geraldton, and at the mouths of the Gascoyne and Ashburton Rivers.

Ancient river gravels are met with on the Nullagine and Ashburton Goldfields, but as a rule they are not common in this district.

Lower Estuarine deposits. The shelly limestones and sandstones at Sharks Bay and along the coast in one or two places probably belong to this series.

Ferruginous sandstones and variegated clays with plant remains are met with on the lower courses of the Gascoyne River, also at the Nullagine; and similar rocks, without the plant remains, occur capping the low ranges in many places throughout this portion of the Colony.

Coralline and chalky limestones with flints, calcareous and ferruginous sandstones and grits form the low coastal cliffs between Geraldton and Sharks Bay.

#### MESOZOIC.

There is a large development of this series in the Victoria district, and good sections are often exposed amongst the flat-topped hills and ranges. In this series of rocks there is nothing to indicate any break between the Oolites and the Upper Lias, as fossils from the same beds are attributed to each of those periods. The division in the table of strata has only been introduced provisionally, as Mr. C. Moore has divided the fossils he described as some of the one age and some of the other, also stating a difference in the matrix.

These rocks have never been properly examined, but now we have a local geologist in Mr. Spalding, who is interesting himself in collecting fossils from them, we may hope to be able to settle this point.

Mesozoic rocks also occur on the Gascoyne River forming the Kennedy Range, and stretch away up North to Cape North-West, but do not seem to extend any further North.

#### PALÆOZOIC.

The Carboniferous and Devonian formations are largely developed in this section of the Colony, but here, as with the Mesozoic rocks, there can be no hard and fast line drawn between them at present, as there seems to be an unbroken series of beds, the lower Carboniferous fauna gradually merging into the Devonian.

These formations outcrop on the Irwin River at about 50 miles from the coast, which it follows in a belt about 20 miles in width, outcropping in the river beds, where the more recent beds have been removed, as far North as the Gascoyne River, North of which they rise and widen out forming a broken table-land which crosses the Henry, Ashburton, and Fortescue, then turning away to the N.E., and disappearing beneath Warburton's great sandy desert, but again making their appearance on the South side of the Kimberley Goldfield.

In spite of the large area over which these formations extend very few beds of the series are exposed, owing to the fact that they have not been disturbed or faulted, and are almost always nearly horizontally bedded, but where dipping slightly in one direction they are invariably found in a short distance to be dipping in the opposite, and the streams have not cut sufficiently deep into them to expose much below the magnesian limestone.

The Upper Carboniferous formation has not yet been identified, but in all probability it exists in some portions of this large area possibly covered by more modern rocks. Rocks of Silurian age have not yet been identified; but it is highly probable that the clay slates and sandstones of the Alma and Ashburton, upon which the Devonian conglomerates rest unconformably, are of this age.

#### ARCHÆAN (METAMORPHIC).

This series of rocks are largely developed, outcropping at Northampton and on the North-west coast; also on the Eastern side of the Palæozoic rocks in the valleys of the large rivers extending away into the interior, where they are mostly covered by modern sandstones, but here and there rise as low ridges in the low-lying ground around the large lakes of Central Australia.

#### IGNEOUS ROCKS.

Volcanic rocks occur along the North-west coast and the Fortescue River as Basaltic flows, and dykes and huge masses of Amygdaloid forming many large rough ranges and hills.

The Plutonic rocks occur all through the Archæan rocks, often forming large bold hills, but more commonly as intruded dyke masses.

The following is a list of the Fossils which have up to the present been found in this Colony :—

#### TERTIARY FOSSILS.

Brissus	...	...	...	Sharks Bay
Patella (2 sp.)	...	...	...	Fremantle
Turbo (2 sp.)	...	...	...	Do.
Fusus	...	...	...	Do.
Trochus	...	...	...	Do.
Cypræidæ	...	...	...	Do.
Natica	...	...	...	Do.
Conus (2 sp.)	...	...	...	Do.
Melania	...	...	...	Do.
Buccinum	...	...	...	Do.
Cerithium	...	...	...	Do.
Litorina	...	...	...	Do.
Haliotis	...	...	...	Do.
Ostrea	...	...	...	Do.
Cardium (3 sp.)	...	...	...	Do.
Cyprina	...	...	...	Do.
Avicula (2 sp.)	...	...	...	Do.
Astarte	...	...	...	Do.
Tellina	...	...	...	Do.

The following list occurs on Mr. Gregory's map :—

Dolium galea
Ranella granifera
Solarium perspectivum
Serapho terebellum
Conus marmoreus
Phasianella australis
Haliotis tuberculata
Bulla ampulla.

## MESOZOIC FOSSILS.

*Entomostaca* ... .. Victoria District

*Serpulce* ... .. Do.

*Mollusca*—

*Belemnites canaliculatus* ... .. Do.

*Ammonites Aalensis*, var. *Moorei* ... .. Do.

„ *Radians* ... .. Do.

„ *Brocchii* ... .. Do.

„ *Macrocephalus* ... .. Do.

„ *Walcottii* ... .. Do.

*Nautilus semistriatus* ... .. Do.

*Eulima* ... .. Do.

*Cerithium Greenoughiensis* ... .. Do.

*Rissoina australis* ... .. Do.

*Turbo laevigatus* ... .. Do.

*Phasianella* ... .. Do.

*Amberleya* ... .. Do.

*Trochus* ... .. Do.

*Rhynchonella variabilis* ... .. Do.

*Ostrea Marshii* ... .. Do.

*Pecten cinctus* ... .. Do.

„ *calvus* ... .. Do.

„ *Greenoughiensis* ... .. Do.

*Lima proboscidea* ... .. Do.

„ *punctata* ... .. Do.

„ *duplicata* ... .. Do.

*Plicatula* ... .. Do.

*Avicula Munsteri* ... .. Do.

„ *echinata* ... .. Do.

„ *inacquivallis* ... .. Do.

*Cucullæa oblonga* ... .. Do.

„ *semistriata* ... .. Do.

*Trigonia Moorei* ... .. Do.

*Cardium* ... .. Do.

*Tancredia* ... .. Do.

*Unicardium* ... .. Do.

*Astarte Cliftoni* ... .. Do.

„ *apicalis* ... .. Do.

*Isocardia* ... .. Do.

*Cypricardia* ... .. Do.

*Pholadomya ovulum* ... .. Do.

*Gresslya donaciformis* ... .. Do.

*Myacites liassianus* ... .. Do.

„ *Sanfordii* ... .. Do.

*Teredo australis* ... .. Do.

*Echini* ... .. Do.

*Polyzoa* ... .. Do.

*Foraminifera* ... .. Do.

*Christellaria cultrata* ... .. Do.

*Cliona* ... .. Do.

*Plantæ* ... .. Do.

## CARBONIFEROUS FOSSILS.

*Pisces*—

*Edestus Davisii* ... .. Gascoyne River



*Cephalopoda*—

Othoceras	...	...	...	Irwin River
Discites	...	...	...	Do.
Goniatites micromphalus	...	...	...	Kimberley

*Gasteropoda*—

Euomphalus	...	...	...	Do.
Pleurotomaria	...	...	...	Do.
Bellerophon decussatus	...	...	...	Irwin River

*Lamellibranchiata*—

Aviculopecten illawarensis	...	...	...	Gascoyne River
„ limæformis	...	...	...	Do.
„ tenuicollis	...	...	...	Kimberley
Pachydomus carintus	...	...	...	Irwin River
Modiola	...	...	...	Do.
Edmondia	...	...	...	Do.
Sanguinolites	...	...	...	Do.

*Brachiopoda*—

Athyris Royssii	...	...	...	Gascoyne River
„ Macleayana	...	...	...	Do.
Spirifer striatus	...	...	...	Do.
„ crassus	...	...	...	Do.
„ vespertilio	...	...	...	Do.
„ convolutus	...	...	...	Do.
„ Kimberleyensis	...	...	...	Do.
„ lata	...	...	...	Do.
„ Hardmani	...	...	...	Do.
„ musakheyensis & australis	...	...	...	Do. and Irwin R.
Productus brachythærus	...	...	...	Gascoyne River
„ tenurstriatus	...	...	...	Irwin River
„ subquadratus	...	...	...	Do.
„ undatus	...	...	...	Do.
Conetes	...	...	...	Kimberley
Orthis (casts)	...	...	...	Gascoyne River
Syringothyris exsuperans	...	...	...	Do., and Irwin River
Reticularia lineata	...	...	...	Irwin River
„ cerebristria	...	...	...	Do.
Orthotetes crenistria	...	...	...	Do.

*Polyzoa and Corals*—

Evactinopora crucialis	...	...	...	Gascoyne River
„ dendroidea	...	...	...	Do.
Fenestella plebeia	...	...	...	Do.
Protoretipora ampla	...	...	...	Do.
Polypora australis	...	...	...	Do.
Hexagonella dendroidea	...	...	...	Do.
Rhombopora tenius	...	...	...	Do.
Amplexus pustulosus	...	...	...	Do.
„ nodulosus	...	...	...	Do.
Cyathophyllum virgatum	...	...	...	Gascoyne and Kimberley
„ depressum	...	...	...	Do.
Plerophyllum australe	...	...	...	Gascoyne and Irwin River
„ sulcatum	...	...	...	Do.
Pachypora tumeda	...	...	...	Gascoyne and Kimberley
Zaphrentis sp.	...	...	...	Gascoyne
Stenopora Tasmaniensis	...	...	...	Do.
Syringopora reticulata	...	...	...	Do.
Anlopore repans	...	...	...	Kimberley

**Stromatoporoidea**—

<i>Actinostroma clathratum</i> ...	Kimberley
<i>Stromatoporella Eifeliensis</i> ...	Do.

**Echinodermata**—

<i>Poteroocrinus</i> ...	Gascoyne and Irwin
<i>Cyathocrinus</i> ...	Do.

**Plantae**—

<i>Lepidodendron</i> ...	Kimberley
<i>Stigmaria</i> ...	Do.
<i>Cyperites</i> ...	Do.

**DEVONIAN FOSSILS.****Brachiopoda**—

<i>Atrypa reticularis</i> ...	Do.
<i>Rhynchonella pugnus</i> ...	Do.

**Cephalopoda**—

<i>Orthoceras</i> ...	Do.
<i>Goniatites</i> (2 sp.) ...	Do.

**CAMBRIAN FOSSILS.****Pteropoda**—

<i>Satlerella Hardmani</i> ...	Do.
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**Crustacea**—

<i>Olenellus Forresti</i> ...	Do.
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**MINERAL RESOURCES.**

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This North and North-west division of the Colony is very rich in minerals.

Gold has been found near Austin's Lake, at the head of the Murchison, at Yuin, on the Ashburton, the Nicol, at Roebourne, Mallina, Peeawah, the Turner, Egina, Pilbarra, the Coongan, the Nullagine, and the 40-mile.

Silver has been found in small quantities associated with the lead ores of the Northampton and Roebourne Districts.

Copper occurs in large quantities in the Northampton District, near Mullewah, near Murgoo, up the Murchison, near Roebourne, and at Whim Well, at which last-mentioned place there is an immense lode.

Lead occurs in large quantities in the Northampton District, and some small lodes have been found near Roebourne.

Antimony, rich in gold, occurs at Mallina and Peeawah in the Roebourne District.

Tin has been found at Pilbarra, the Western Shaw, and small traces throughout the North-west.

Iron in large quantities, and of good quality, throughout the district.

Zinc in small quantities in the Northampton District.

Coal has not yet been found of any commercial value, but as in this portion of the Colony the Carboniferous rocks are so largely developed it is highly probable that it will be found.

Graphite is found in the Northampton District and on the Gascoyne River.

Mica has been found near the Shaw and on the Gascoyne.

Kaolin occurs in large quantities at the Nullagine.

The following is a more detailed account of the principal discoveries that have been worked :—

### NORTHAMPTON DISTRICT.

The mineral-bearing portion of this district is to be found in the low broken table-land about 20 miles wide, bounded by the sea on the West, by the high sandy plateau on the East, the Greenough River on the South, and the Murchison River on the North, covering an area of about 1,000 square miles.

The upper strata is of Mesozoic age, and through which the streams have cut many deep channels and gorges leaving flat-topped ranges and hills, which attain an elevation of between 500 to 600 feet above the sea level. In the beds of these streams, and in those other portions of the country where the more recent formations have been denuded, the underlying Metamorphic rocks, containing mineral veins, are exposed.

The rocks are of a highly metamorphic character, *e.g.*, micaceous slate, mica schist, crystalline schist, gneiss, granite, quartzite, and quartzose sandstone; often containing garnets and iron pyrites. Their general strike is North and South, but owing to their highly broken condition and the numerous dyke masses traversing them they are often thrown many hundred yards out of position.

Diorite, granite, and felstone form the greater number of the numerous dykes that occur, and they bear a close relation to the lodes; their strike is 20° East of North.

Quartz veins, often containing crystals of tourmaline, felspar, and large plates of mica, are numerous, as cross-courses, wherever the Metamorphic rocks outcrop.

The lodes, which follow the same strike as the dykes, 20° East of North, are large and well-defined. They are generally capped with quartz and oxide of iron (gossan), and contain the following ores :—

Malachite	...	...	green carbonate of copper
Azurite	...	...	blue do.
Copper Glance	...	...	sulphide of copper
Chalcopyrite	...	...	sulphide of copper and iron
Galena	...	...	sulphide of lead
Cerussite	...	...	carbonate of lead,

associated with quartz, calcite, barytes, often also with small quantities of blende (sulphide of zinc), iron pyrites, and a ferruginous graphite.

Lead and copper were first found in this district about the year 1840, when several very rich lodes were mined by English Companies, but owing to the fall in the prices of lead and copper they were abandoned a long time ago.

It is very distressing to see the extensive plant and buildings going to ruin, the large quantity of good ore at grass or ready for shipping, 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 is now being tested, and it is to be hoped that the results will be successful. Several of the old mines that 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 so high.

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 is 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 over this district; if this metal is found, it will probably not be associated with lead, but with copper or iron gossan.

#### NANGRANG HILLS.

In the early part of 1890, gold was discovered in a reef on a low range of hills, about 5 miles to the Eastward of Yuin station.

It is a large reef of a bluish glassy quartz, striking E. and W. and apparently dipping to the North, but going down nearly vertically as far as can be judged from a small hole about six feet in depth.

The rocks follow the same strike as the reef, namely, E. and W., and are quartzites and mica slate, with granite dykes and ironstone lodes.

The low range of hills which is strewn with quartz rise from a large alluvial plain, which is also strewn with quartz near the range.

There is plenty of water but timber is scarce, but when the position is considered, if the stone is of any value at all, it should pay very well to work.

At the present moment there seems to be a good deal of uncertainty about the richness of the stone, as the assays have varied very greatly although some of the stone crushed gave a very good return, and many pieces of stone not showing any gold when crushed and washed yielded very nice prospects. One thing is certain in a settled district like this, companies or claim holders should be made to fulfil the labor conditions, for they have no excuse in not doing so in a place like this, and it only leads one to look upon the whole thing with suspicion, for were it as good as represented it would pay to put on the extra men and work the area instead of obtaining exemption on the grounds of putting on machinery which never seems to come.

#### MULGA MULGA, OR BIEREN.

In the early part of 1888, gold was discovered by Mr. Birk in a small reef on a hill between Austin's Lake and the Weld Range.

The reef is small and not well defined at the surface, but shows fine gold in places. It is of a saccharoid character, containing a little pyrites and sulphide of antimony.

The reef strikes a little E. of N. dipping to the West where the gold was found, but higher up the hill there is a larger body of stone dipping to the East. Its width is very variable, but is generally between 2 and 3 feet.

It was opened up, but later on abandoned.

This is situated on the Northern extension of the Yilgarn line of country, and there are many nice looking reefs about here which should be prospected; also this belt of country to the Northward, on towards the Murchison.



## THE ASHBURTON GOLD DISCOVERIES.

### THE TOP CAMP.

Alluvial gold was first found on the Ashburton River, at the beginning of 1890, about 14 miles S. of the tree marked 45 (triangle), in a creek flowing down a gorge, about 200ft. deep, between steep cliffs of clay-slate capped by almost horizontally bedded limestones.

These clay slates dip at a high angle to the N.E. They are intersected in places by small quartz reefs or leaders, in many cases ferruginous, but up to the present none of them have proved to be rich in gold. The capping limestone (dolomite), the underlying shaley sandstone, and ironstone beds are probably a Northern and Eastern extension of the Carboniferous and Devonian formations so largely developed on the Lyons and Gascoyne Rivers, though as yet no fossils have been found by which their age can be definitely fixed. The beds dip at an angle of 20 deg. S., resting unconformably upon the upturned edges of the clay-slates (Silurian?) and from their line of junction many strong springs break out. To the S. these limestones form a large flat-topped range or table-land, and completely covering the clay-slates which are not exposed again, even in the gullies and the stream beds, although these are often of great depth.

There cannot be the least doubt that the gold in the gullies has been derived directly from the mineral veins in the clay-slates, for it has never been found in those gullies where the slates are absent, as the overlying limestones contain no mineral veins. The mineral veins must be of great antiquity as they were formed prior to the deposition of the superincumbent Carboniferous and Devonian rocks, for in no case do they extend beyond the line of junction.

It is rather remarkable that there are no conglomerate beds in this district at the junction of these two formations; the limestone for the most part resting directly upon the upturned edges of the clay-slates. Should any such conglomerate or detrital deposits be discovered, they should be prospected, as it is highly probable they would prove rich in gold.

The gold on this field is very pure, and free from quartz and ironstone. All the larger pieces were of a flat bar shape, owing to their having been formed between the slate ledges by the slow accumulation of fine gold, which by the gradual accretion, due to the deposition of the minute quantities of gold held in solution by the water, has formed into one piece, taking the shape of the cavity or ledge. The largest nugget yet found weighed about 6lbs., and it is estimated that from 9,000 to 10,000 ozs. have been taken from these diggings. The run of gold in the main gully extended for over one mile in length, but most of the gullies N. and S. for a distance of about five miles along this line have proved rich.

Whence this gold was derived it is impossible to say without carefully mapping and prospecting the area, but it is highly probable that it results from slow accumulation from poor quartz and ironstone reefs, though in some cases it may have been washed from older "leads" and conglomerate beds, which, if they existed, must have followed the present courses of the creeks, for no traces of such beds are now to be seen. The deepest sinkings on this field are from two to three feet.

All these gullies will pay to work again and again after each heavy shower of rain, as their beds are so small and deep that they will act as ground sluices, re-sorting all the dirt which has been imperfectly treated by the process of dry blowing.

### THE "SOLDIER'S SECRET" OR MIDDLE CAMP.

This field is situated about 20 miles N.W. of the former, and about 14 miles up the Mount Blair Creek. It is very similar in formation to that of the Top

Camp, except that the flat-topped limestone hills are here two miles to the S. The gullies run between steep clay slate hills and carry gold for distances of 200 to 400 yards. The gold is much finer, and it is estimated that 1,500 ounces have been found up to the present, whilst the diggings cover an area of about 5 square miles. Messrs. Cook and Green have sunk a well in the bed of the Mount Blair Creek, where there is a good supply of water.

To the N.W. of the Camp there are the remains of an old lead crossing some low hills, where fine gold occurs everywhere on the surface and in pockets on a false bottom of travertine limestone. In the wash a great deal of ironstone, some of it magnetic, is found with the gold, but, as at the Top Camp, very little quartz.

Some large quartz reefs cross this line of country, forming high hills, but it is not at all probable that they carry gold; the smaller reefs and ferruginous veins are far more promising. The largest pieces of gold found on this field weighed about an ounce each, but larger may have been found and not reported.

#### THE DEAD FINISH.

This field is situated on the North side of the river, about 5 miles North of tree marked 35 (triangle), and 6 miles North-west of Gregory's Deep Creek. This patch of country is not nearly so hilly as the other fields, and there is much more quartz, from which it is probable that the gold has been derived, for it has been found in the gullies up to, but not higher than, the quartz reefs. These diggings are the "stand-by" for any man who is penniless, for he can always be certain of obtaining enough gold at these workings to pay his way. The gold is mostly shotty in character. The largest piece found weighed about 8 ounces, and it is estimated that about 1,000 ounces have been obtained. Unfortunately water has to be carted about 6 miles, and the gold is not found so easily as in some of the other diggings.

#### THE GORGE.

These diggings are situated a little to the South-West of the Dead Finish, but on the other side of the river. Some nice nuggets were found, and a rush set in, but the extent of the country was neither large nor rich enough for a number of men, but the few did very well.

#### MOUNT MORTIMER DIGGINGS.

These diggings are situated about 7 miles S.E. of the hill marked on the new maps as Mt. Dawson, but which has always been known in the district as Mt. Mortimer.

The country here is slightly different from the upper fields, as the clay slates are often replaced by sandy slates and ferruginous sandstone beds, and is generally harder, while the gullies are not so steep. The "sinking" is, as a rule, deeper, and being so much harder a claim takes longer to work out.

In one gully a quantity of large pieces of gold were found, the largest weighing 56 ounces, but in the other gullies the gold, as a rule, is not found in large pieces, and is generally associated with a good deal of ironstone; indeed, the latter is often included, so that the lumps have to be crushed in order to separate the gold. The nearest water is 2 miles distant. The claims took a month or six weeks to work out here, so money was not made so easily as when slate bars had only to be raked with a pick.

#### GENERAL REMARKS.

An auriferous belt of country extends from Hicks' on the Ashburton, following this river in a S.E. direction for about 150 miles. It is bounded on the S. by the Barlee Range and a flat-topped table-land, which follows the main course of

the river at a distance of 14 miles to its S. To the N. it extends across the Ashburton and Hardy Rivers to Mount Wall and Mount de Courcey, *i.e.*, a distance in a Northerly direction from the river of 20 to 30 miles, which gives an auriferous area of about 10,000 square miles.

The rocks are identical with those of the auriferous areas of the other Colonies, and entirely different from anything in this Colony to the South of this district. The river follows the strike of the rocks, which dip mostly to the N.E. They consist of clay and chloritic slates, sandstones, and quartzites (the slates being often of the cleavable kind used for roofing purposes); they are intersected by numerous quartz and ferruginous lodes, which have often highly altered the slates in their immediate vicinity, and these whitish and highly mineralised portions of the country should be prospected. There is a most promising tract of this class between the Dead Finish and Gregory's Deep Creek, and two or three more on the road down the river.

The general features are high slate ranges to the S., backed up in the distance by flat-topped limestone ranges, large alluvial plains following the river chiefly on the N. side, with here and there low isolated slate hills rising up through the plain, and some miles away to the N. rough slate ranges again recur.

Up to the present very little prospecting has been done, as only the rich patches in the shallow ground are considered worth troubling about.

In the large plains of the Ashburton there are sure to be some very rich deposits of gold found, but as the prospecting will be most expensive work, no one will undertake it, unless he be granted a protection area, until the course of the leads has been ascertained.

Taken as a whole this is a most promising tract of country, and will, without doubt, prove a rich and lasting goldfield, but it is highly probable that before this is proved that everyone may leave the field under the impression that all the gold is worked out when they have scratched all they can from the slate bars of the small gullies in the ranges, but there will still remain that which will yield the best returns, *viz.* : the deep ground as yet untouched.

This field, as far as it has been worked, has produced the most gold in the shortest time of any field in the Colony, for about 15,000 ounces have been raised in about six months.

## THE PILBARRA GOLDFIELD.

*Proclaimed area, 32,000 Square Miles.*

The Pilbarra Goldfield is situated in that portion of this Colony known as the North-West, that is, the district lying between the coast on the North, the Fortescue River on the South, and the De Grey River and Warburton's Great Sandy Table-land on the East. It is one of the most promising mineral areas in this Colony, its general features being a large low alluvial plain which follows the coast, broken here and there by rocky hills, whilst to the South and East rises a high table-land.

Several large rivers have there sources on the Northern 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 trend towards the N. and N.W. in deep gorges cut through the limestone and quartzite 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, from which 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.

#### MALLINA.

In 1888 some very rich stone was found at Mallina, 70 miles East of Roebourne, and about 20 miles South of the sea; the reef 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 improves in this direction, carrying a little gold in the solid stone, the richest stone being on the footwall.

This claim and the adjoining ones have now been abandoned, but will probably be re-opened when other mines in the neighborhood prove payable.

#### ALFRED ARGLES GOLD MINING Co.

This is on a reef running parallel to, and the shaft being a little to the N.E. of, the Mallina claim.

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.

This area embraces both Martin's and Lady Carrington claims. On the former no work has been done during the past two years, but on the latter machinery has been erected, and two or three very satisfactory trial crushings effected. The battery is one of Bennett & Speechley's, and seems to work splendidly, notwithstanding the refractory character of the ore owing to the presence of so much antimony. The engine is a 5-horse portable Tangye, but is not powerful enough to work battery, pumps and saw. Its chief defect is

the smallness of the fire box, necessitating much labor in cutting up the wood, and making it very difficult to keep up a good head of steam. There was too much water in the mine to allow of an inspection being made, but from its proximity to Martin's shaft on the same lode, it will probably be very similar to that described above. Although these trial crushings have all proved very rich, sufficient ore has not yet been treated to prove the mine. There is abundance of fuel in the immediate neighborhood, and the water from the mine is very good.

A large quantity of the stone crushed was almost pure sulphide of antimony (stibnite), rich in gold, which first-named metal is entirely lost by this process. The question is whether it would not pay better to concentrate the pulverised ore and send it away to be treated, by which process not only the antimony would be saved but more gold, as the antimony must carry away gold into the tailings.

#### PEEAWAH.

About five miles to the East, at Peeawah, 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. Samples assayed yielded 10oz. 3dwt. 19grs., 7oz. 10dwt. 6grs., and 16dwt. of gold to the ton, respectively. A shaft has been sunk, passing through the reef near the surface, to a depth of 47 feet (water level).

Several other areas were taken up here, but they have all now been abandoned owing to the superior attraction of the recent discovery of alluvial gold.

#### EGINA.

This field is situated on the E. side of Peeawah, about 40 miles from the coast, and 5 miles S.W. of Mt. Langenbeck.

It was on this field, in 1888, that the first discovery of alluvial gold was made in this part of the Colony. The field consists of a compact patch of shallow diggings, amongst clay slate hills containing very little quartz. This patch of country extends a few miles S. and also to the Westward in the direction of Croydon, but owing to the scarcity of water in the latter direction very little prospecting has been done there. New and rich discoveries took the men away from this field, but as these get worked out, they will gradually return, as there is still a good extent of country that has not yet been touched.

This patch of country is very similar to the Ashburton, and, as on that field, no mineral vein carrying gold has yet been found.

#### PILBARRA.

This narrow belt of auriferous country is situated about 12 miles to the South-East of Egina, and about 8 miles West of the Yule River. It is about 2 miles in width, running in a North-Easterly and South-Westerly direction, and is bounded Easterly by a mass of intrusive granite, and Westerly by a razor-back range, which is a great dyke of ferruginous quartz. The gold on this field is not the least waterworn, and occurs in rich but very limited patches almost on the surface, where it has been left when the quartz from the rich leaders was washed away. These patches extend in a South-Westerly direction for about 6 miles, but nothing in the shape of a lead has yet been discovered, although down the creek, at the end near the Warden Camp, there is a very promising-looking flat, which has not as yet been prospected. The Broken Reef is the most important feature of this field; several claims were taken up on it. On one of these a Huntingdon Mill was erected, and although this was one of the best machines yet imported into the Colony, and was well managed, the stone did not

prove rich enough to pay. It is a great pity that the investors from the other Colonies and elsewhere do not insist upon getting reliable reports from independent sources on such areas as may be offered to them before going to the expense of erecting machinery. If they would only apply to the Government here, they would be informed as to the best manner of obtaining thoroughly trustworthy information. The gold in the reefs of this district is too patchy to be promising, but in some cases there is not the least doubt that very rich bunches of stone will be found, though not of sufficient extent to make this a reefing field, but it will probably last out for some time as an alluvial ground, as rich patches are continually being found.

There are no true veins on this field, the reef masses being lenticular segregations, often of very great size, but it is not at all probable that they will extend in depth any more than they do at the surface. Although these latter, as at the Broken Reef, appear to extend for a considerable distance, it will be found, on closer examination, that it is not one reef but a series of these lenticular masses, one lapping on to another.

These splits and fissures owe their origin to the great mass of intruded granite immediately to the Eastward and the close proximity to it. This in itself would be sufficient to preclude any hope of these reefs living down for any great depth.

#### NULLAGINE.

This field is situated on a creek of this name, which is a branch of the DeGrey River. By road it is about 300 miles to the Eastward of Roebourne, but in a direct line only about 200 miles, and about 130 from the coast.

Alluvial workings of three classes occur: 1st, the alluvium of existing creeks. 2nd, the alluvium of older creek beds, but in conjunction with the present streams. 3rd, old alluvium deposits or deep leads bearing no relation to existing streams or configuration of the country. The most recent deposits are easily worked, for nature is at work here to-day ground sluicing debris from the older formations; therefore no sinking is required, and the dirt is so free that it can easily be dry-blown. The older alluvial deposits are found in the river flats, where the auriferous gutters are crossed and recrossed by the present streams. The sinking here is about 10ft., and very hard work owing to the fact that the deposits that overlay the dirt are cemented masses of quartz and boulders of other hard rocks. The dirt from these is screened on the spot and carted to the creek, there to be sluiced by water raised from pools or shallow wells by Californian pumps. The deep leads are cut across by the present valleys, and can be traced from hill to hill. Here the sinking is very variable in depth, the whole gutter in some places appearing on the side of a cliff where the work merely consists in driving, while in other places shafts up to 60ft. or 70ft. have to be sunk to work the same lead. Up to the present only one of these leads has been discovered, but there cannot be the least doubt that more will be found when the small hills between the conglomerate range and the creek are thoroughly prospected.

All three of these deposits are very rich, but no one can estimate the quantity of gold with any degree of accuracy, as so much leaves the Colony without ever being reported; but there is no doubt that more has been taken from this field than from any other in the Colony.

To the West of this field are hills of nearly horizontally bedded conglomerate rocks, probably of Devonian age, in which reef gold occurs in small veins of quartz and ironstone which follow, and indeed fill in all interstices between the larger boulders. They are very rich in places, in fact so rich that it pays to "dolly," and the gold in the flat close by is evidently derived from these veins. This deposit is of very great interest, as nothing like it has before been found; for the gold although occurring in an alluvial deposit is reef



gold and not alluvial, for it has been deposited subsequently to the formation of these boulder beds.

Four miles to the Eastward is a very nice patch of auriferous country, where a great deal of gold has been obtained absolutely on the surface. The rocks of this belt are kaolinized slates with numerous quartz reefs and leaders, some of which have been worked as long as the stone was rich enough to "dolly," but since then they have been abandoned, as reefs at present are rather a drug in the market, but when there is more capital in the Colony this will prove a very rich reefing area.

The country to the Eastward for 50 miles, and for a considerable distance to the North, is of an auriferous character, and as soon as the rain sets in will be thoroughly tested.

Taking all things into consideration, there appears to be a splendid future for Nullagine, although this district generally is patchy, but these patches, when found, have always proved very rich.

At the present time there are a good many men at work on the Turner, a river a little to the East of Peewah. At the Coongan, where the largest nugget was found, there are still a few men, but owing to the scarcity of water they cannot do much; but there is no doubt that where those large nuggets were found more will be discovered, and that this belt of country will also probably extend across to the Turner. Gold will probably be found from the Coongan in a N.E. direction, starting round the Northern face of the table-land and so away round in a S.E. direction to the Nullagine, and also between Look's and the Coongan there is a very promising belt of country.

The country to the East of Nullagine is called the Forty Mile, but there seems to be no definite place to which this name applies; but if one may judge from the opinion of the diggers, who, as a rule, are not over sanguine, there must be some very fine country in this direction.

In a country of this description a more or less detailed geological survey would be of very great assistance to the diggers, but at present the smallness of the staff prevents work of this kind.

#### THE NICOL.

Early in 1890 gold was found on a small river called the Nicol, about ten miles West of Roebourne, by some men engaged by Mr. Sholl to sink post-holes for a fence. The gold occurred about the surface, and was at first easily and cheaply obtained, but later on, when the lead was traced down into the flat, more work had to be done to gain it. This small patch of gold-bearing country is so little above the sea level that no deep sinking has at present been possible, owing to the vast volume of water encountered; but it is highly probable that the deep ground carries gold. At the present time this field is nearly deserted, as the limited area over which gold has been found is worked out, and no reefs have as yet been discovered. The gold was probably derived from rich patches in the quartz veins and leaders, which in this district are much broken and of very variable thickness, owing to the many intrusions of masses of granite and trap rocks.

Besides gold, this district is rich in many other minerals, the most important of which (and the only other which is at present being worked) is copper at the Balla Balla Creek, about 15 miles nearer Roebourne than Mallina, and about 15 miles from the coast. Here there are low rolling hills of clay-slate, with numerous quartz veins of a highly promising character for gold.

#### WHIM WELL COPPER MINE.

When it is stated that this mine was worked by about four men for a month or two last year, and that from the results of their work the syndicate were able to

pay all the working and preliminary expenses, some idea can be gained of the richness, size, and quality of this lode. It is hardly right to call it a mine, for no mining will be required for years, even if it be worked on a large scale, for there is a hill of copper ore that only requires quarrying. The lode is on the surface, forming the face of a low ridge running E. and W. for about half-a-mile, when it is lost at both ends. It dips gently to the North at an angle that allows it to be worked comfortably on the footwall, *i.e.*, with just sufficient pitch to allow masses to be rolled down, and yet not too steep for men to walk upon it. It is 12ft. in thickness where it has been opened, 6ft. of which can be dressed without the slightest trouble to 30 per cent., and with care even to 40 per cent., whilst the other 6ft. can be dressed to 20 per cent. with a little trouble, although if a proper dressing plant were erected better results could be obtained. The lode appears to be good in quality throughout its entire length, and is nowhere, as far as can be judged from the surface, less than 6ft. in thickness, and is mostly a good deal more. The ore consists of carbonate (chiefly green), but there is some blue also in the poorer parts of the lode, while in the rich some beautiful specimens of malachite have been obtained. Considering its proximity to the coast (15 miles) and comparatively shallow depth at which good water can be obtained, and the enormous mass of rich ore in sight, this should prove a very valuable property.

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 oxides of iron and copper, in some of which 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 owing to the low price of copper, but as the ore at the surface is very fair, and the lodes are so large and so near a port that they could be worked cheaply, now that 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 now separated from copper so much more economically than it could twenty years ago.

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. The galenas and cupriferos gossans of this district are well worth testing.

Tin has also been found in the alluvial workings at Pilbarra, but could not be worked as the Mining Regulations for working gold and tin clash, and no larger area than an alluvial digger's area can be granted on a goldfield. A very rich deposit of coarse stream tin occurs near Mr. G. & J. Withnell's station on the Shaw, which assayed 71 per cent. of metallic tin; the only drawback to the working here is its distance from the coast, but should a good lode be discovered, there is not the least reason why it should not be profitably worked.

Prospects are obtained in many places between Pilbarra and the Nullagine, all of which country is of a highly Metamorphic character, highly favorable for deposits of tin; and there is not the least doubt that before long some great discoveries will be made.

The North-West district, as a whole, is rich in minerals; wherever the slates occur gold is found, and wherever the granite outcrops prospects of tin may be obtained, and also mica of first class quality. In the trap country, veins of beautiful chalcedony and opal occur, although up to the present no precious opals have been found; its matrix and character are so similar to those of the Queensland specimens that they are worth prospecting. Associated with these also are beautiful banded agates, and there is no doubt but that other precious stones will be found. In the table-land to the south, coal shales exist, and

should any good coal seams be discovered here, they will be of immense value in the working and development of the mines. Copper occurs near Roebourne and at Whim Well, while galena has also been found near Roebourne, and antimony at Mallina and Peeawah. Enough has been said to show that mineral deposits of great richness do exist in this district, and that there is a brilliant future for its mining industries.

### CONCLUDING REMARKS.

The gold deposits which have up to the present been worked have only been the small rich patches, which were easily worked in a country where water is scarce; therefore all the old workings will pay well to work over from time to time, as large quantities of gold are left behind which will be re-sorted by the creeks when in flood.

There are some nice patches of country on the Murchison near the great bend, and also near Mr. Nairn's station.

The country from Austin's Lake to the head of the Murchison and across to the Gascoyne should also be prospected.

Through the N.W. a great deal more gold will be found, in fresh rich patches, as soon as rains enable prospectors to travel about.

The Ashburton is only in its infancy, and it is highly probable that some very large deposits will be met with in the deep ground when it comes to be tested, and that this belt of country will prove to be a *permanent goldfield*.

A belt of Carboniferous country, about 20 miles in width, extends from the Irwin River to the Northward, crossing the Greenough, the Murchison, the Wooramel, the Gascoyne, the Lyons and Minilya Rivers, then spreading out over the Henry, Ashburton, and Fortescue Rivers, and forming the great table-land which stretches away to Kimberley. It is true that up to the present only carbonaceous shales have been found, and the fossils at present described all belong to the Lower Carboniferous or Devonian series, but when the enormous area over which these rocks extend is taken into consideration, and as they are mostly covered by Mesozoic and more modern rocks, it is highly probable that true coal measures do exist here.

The tin in the N.W. would be worth prospecting, and so would the mica, but most of the other minerals are at present too low in price to be worth taking up.

### DESCRIPTION OF THE ROUTE TRAVERSED FROM GERALDTON TO THE NULLAGINE.

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 the sand plain to the crystalline rocks, with

numerous quartz reefs, which run nearly North and South, being the same line of beds that form Peterwangy Hill and 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 claystone 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.

From Bunbenoo to Yuin across a series of low hills of sand or light loam, with the older rocks again making their appearance about three miles North of Bunbenoo; then alluvial plains to the Greenough River.

Between Yuin and Murgoo the water parting of the Greenough and Murchison Rivers is crossed. This consists of a high belt of country running in an East and West direction, the main portion of which is granite flanked on either side by Metamorphic rocks, the whole often being covered by the newer sandstones. On approaching Murgoo the country opens out into the large alluvial plains of the Sandford River, with here and there a bold range mass of crystalline rock or huge mass of bare granite rising abruptly to a considerable elevation from it.

Between Murgoo and Nookawarra there are very few points of any geological interest, the country being mostly large alluvial plains, with here and there outcrops of granite.

From Nookawarra to Berringarra, soon after starting, a schistose range, the extension of the Mt. Hall range, is crossed, the rocks of which strike nearly North and South, and dip to the East, there is a great deal of quartz and some beds of mica schist. From the top of this range an extensive view is obtained of the large alluvial plains of the Murchison River, with the large hills called Mt. Mathew, Mt. Hall, and Mt. Gould, rising up from them.

Underlying the alluvial plains is a deposit locally called opaline; it is a carbonate of Magnesia cementing sand, gravel, and creek rubble together. It is a sure indication of water, which it overlies and from which it has been deposited by the evaporation of the water which has been drawn up by capillary attraction, the salts remaining and cementing the upper beds into a solid conglomerate or breccia.

Between Berringarra and Milly Milly the road follows the alluvial plains of the Murchison River, and after crossing it they extend some five miles in a Westerly direction, but between this point and the Yarra Yarra Creek there are low ridges of ferruginous sandstone and small patches of travertine limestone.

Down this creek there are rich alluvial flats, with here and there outcrops of crystalline rocks and slates, with quartz reefs of a very promising character, especially near Mr. Nairn's Station.

This Yarra Yarra Creek is a branch of the Wooramel River, but as this, as well as the river, has not been completely surveyed yet, only portions of it are at present shown on the map.

Between this Creek and the Wooramel River the country consists of flats and stony ridges with ranges to the North-west, but on nearing the river the country rises to a high sandy table-land with quartzites, sandstones, and limestones of Carboniferous age outcropping here and there.

The Wooramel itself here flows in a large flat of 6 or 7 miles wide with low cliffs on each side where sandy shales, grey shales, sandstones and limestones with fossils are exposed, but up to the present no coal seams have been found, as no prospecting has yet been done here.

After crossing the Wooramel and ascending the sandy hills on the North side, the country gradually rises forming the water parting between this river and the Dairie Creek, a tributary of the Gascoyne River. This water parting consists of an elevated stony table-land called the Byroo Plains, it is the Southern extension of the MacAdam plains at the head of the Wooramel, and is strewn with water-worn boulders of quartz and crystalline rocks (probably resulting from the weathering of a conglomerate bed of Devonian age), in some of which gold is said to have been found. About 10 miles from the junction of the Dairie and the Gascoyne, the Carboniferous rocks again make their appearance as table-topped hills, and from a well in the bed of the creek a large quantity of soft blue shale, containing large quantities of pyrites, was raised. Water in these beds, if met with, is of no use, for it is generally salt or contains a large quantity of alum. These shale beds here, as on the Irwin, are never seen in sections, as they are generally met with below the beds of the rivers, and are, where they have been tested, of great thickness, as no well has yet been sunk through them, but if this were done a large supply of fresh water will probably be struck, and if not under sufficient pressure to flow at the surface would rise a considerable height in the well.

As a large belt of country N. and S. of this point, about 50 miles in width, is dependent for its water on the soakage in the sand of the river bed, this would be well worth testing with a bore, and besides there is an extra inducement for there is always the chance of striking a coal seam. This belt of Carboniferous country strikes in a North-Westerly direction, crossing the Gascoyne, the Wyndham, the Arthur, and Lyons Rivers, and so passing on to the Northward on the Western side of Mt. Sandeman, and between it and the Kennedy Range.

This belt of country presents the strange appearance of large flats with tent-like hills. The upper beds of this series are crystalline limestones full of corals, which dip at an angle of  $10^{\circ}$  to the Westward. Underlying these are shaley beds full of very perfect fossils of Lower Carboniferous age, some of which have been even described as Devonian; the conglomerate bed containing boulders of crystalline rocks are always found at the bottom of this series, resting upon clay-slate or shales which are of great thickness.

The tent hill sections consist of a capping of ferruginous sandstone or crystalline limestones, beds of grit, shales, ferruginous limestone, gypsum beds, shaley limestone, and sandy shales.

The fossil beds are very local; in some places the shaley beds are nearly composed of them, whilst in others very few are met with. One hill was the curiosity of the district, called fossil hill. It is a low hill close to the Wyndham River which was completely covered with fossils, but though there are still many there, the best and most perfect have been taken away, mostly to be ground to powder in packbags, only the most solid being saved.

The Gascoyne River itself, between Dairie Creek and the Lyons, flows in a large sandy bed a mile and more across, skirted on either side by low alluvial plains. In the bed of the river fresh water can be obtained anywhere by sinking a few feet in the sand. The Lyons River, which is the main branch of the Gascoyne, is very similar in character to it, excepting that for the first 100 miles from its junction, on the Eastern side of the Kennedy range, its course is nearly North and South.

For the first 40 miles North from the junction, the river flows in a large sandy bed, with the bold Kennedy Range to the Westward, and large alluvial and stony plains with flat topped hills of Carboniferous age to the Eastward, but this latter belt of country having a bearing to the North-west, and the river rather inclining to the Eastward, crosses it, making a sharp bend to the East, where the hard crystalline and intrusive rocks are met with forming Mt. Thomson.

From this point the road follows up the Alma River through hilly country, the rocks being mostly clay slate and quartzite till the head of the river is

reached, where in the dividing range between the water shed of the Gascoyne and Ashburton large masses of intruded granite make their appearance.

From this high ridge there is a fine view of the valley of the Henry and the Barlee Ranges, and to the South towards the Lyons and Mt. Thomson.

Following on down the valley of the Henry, as far as Blue Rock Pool, the rocks are slates and quartzite, while in the bed of the stream, which flows through large alluvial and stony plains, are boulders of crystalline rocks.

Blue Rock Pool is formed by some heavy blue quartzite bars crossing the river, which have formed a natural dam.

Below this the hills close in rapidly towards the river, which flows for about 40 miles almost through a gorge, with heavy springs breaking out from the high cliff of magnesian limestone, dipping from  $20^{\circ}$  to  $30^{\circ}$  to the East; but as no organic remains have yet been found in these rocks, their age is uncertain, but they are probably of Devonian age.

The Barlee Range is composed of this formation, and would be very interesting from a geological point of view, as one of the few fine ranges where Palæozoic rocks are exposed; but towards the end of the dry season it is almost impossible to travel in this country. Leaving the Henry and striking to the Eastward, over stony plains, around the North side of Mount Florrie, where the rocks are mica schists and granite.

To the N.E. of Mount Florrie the belt of auriferous country commences, and near Mr. Cumming's station there is some very nice looking quartz. This country is all clay slate, highly cleaved, weathering a reddish color, and forming rough conical or peaked hills, whilst the quartz, which is patchy, is of a promising appearance, the whole belt of country being very similar to auriferous country in the Eastern Colonies.

From Hicks' station, on the Ashburton, the river to the Eastward runs N.W. and S.E., following the strike of these slate rocks for about 150 miles; this belt of country being from 15 to 20 miles in width.

Following the river in the South-East for 20 miles over large alluvial plains, between the Harding and Ashburton, with the bold range to the North, the principal peak in which is Mount De Courcey. At 20 miles from Hicks' the river flows nearly North and South, and the flat-topped ranges to the West close into the river, whilst on the East the country is more broken, slate ridges and peaks rising above the flat here and there, the country becoming quite rough near Mount Dawson.

Five or six miles to the South of Mount Dawson, on the edge of this hilly country, the Mount Mortimer gold workings on this river are situated, and to the South of these peaked slate hills the flat-topped range or table-land is seen.

To the South-East of Mount Dawson the country is more open for about 15 miles, but then suddenly closes in on the river, which flows through what is almost a gorge for some miles.

At Gregory's Deep Creek the country opens out to the North, the large alluvial plains extend for several miles, but on the South it follows closely the Capricorn Range.

A little way up the Mount Blair Creek, which joins the Ashburton River at the end of the Capricorn Range, is another patch of gold workings, and about 15 miles further up the river, on the same side, is the top or main camp.

To the South of this belt of gold-bearing country the flat-topped table-land follows the river at a distance of from 5, 10, to 15 miles. In this table-land the branch creeks take their rise, flowing in deep channels cut through the hard limestone, from which, in many places, fine springs burst out. Up to the present all the rich patches of alluvial diggings that have been found are situated



amongst the roughest looking country, which, from a distance, looks like a series of sharp peaks.

The slates along this river vary very much in character, sometimes being almost like a quartzite in hardness from the great amount of silica they contain. Where these rocks occur the hills are generally bolder and the rocks more massive, and do not split up quite to the same extent as the clay slates.

On the large flats are what would be generally considered the best indication of gold where quartz reefs occur in belts of indurated clay slates, but at present gold is too easily obtained by scratching in the little gullies.

The road to the North leaves the Ashburton about 15 miles to the N.W. of Hicks' station, and strikes away North on the West side of Mt. Edith over plains strewn with quartz.

Near Mt. Amy ironstone, ferruginous sandstones, quartzites, slaty and limestone beds, with veins of jaspery quartz, outcrop, and this belt of hard stony country with flat-topped hill to the N. and S. extends to the Cane River. This broken table-land country extends on to the Robe River, where the hills are capped with ferruginous sandstone, and there are several large amygdaloid dykes.

From this point to Mr. O'Grady's station the country consists of large plains strewn with pebbles of quartz and amygdaloids.

Between here and the Fortescue River the road passes along the large alluvial plains which here follow the coast. They are 20 or 30 miles in width, and fringed along the shore by mangrove swamps and salt marshes, with a low range of hills to the landward, which form the edge of the great table-land of the interior. After crossing the Fortescue River low rough ridges of quartzite outcrop here and there, and the flats are strewn with stones in many places, and trap dykes are often met with.

Close to Mr. Clarkson's station a huge granite dyke outcrops, and this line seems to strike in an Easterly direction.

Between this station and Roebourne there are large alluvial flats, with here and there outcrops of crystalline rock, which form low rough ridges, and are much more frequent in their occurrence as you approach Roebourne.

Gold has been found here on the Nicol River, in a rich and easily-worked little patch, but unfortunately it was impossible to trace it down into the deep ground, as there was too much water, the ground itself here being very little above the level of the sea.

Near Cossack there are some bold headlands of crystalline rock with dykes of tourmaline, which from the sea look as if tar had been poured down them.

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 the swamps 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 also 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 on to 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 from the sea 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 near Mt. Brown, 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 a near approach 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 stained 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.

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 feldstone dykes. 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 often so steep as to be quite difficult to climb.

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.

A large reef of barren looking white quartz rises here from the flat, and on the side of this some very rich specimens of auriferous quartz were found.

There are also two or three other outcrops of quartz, rich in antimony and gold, but these, as a rule, do not rise much above the surface. The rocks, which are here mostly calcareous slate, strike E. and W., but the country is a good deal broken, owing to the intrusion of these immense amygdaloid masses. The road from here to Egina strikes South following the Peawah River into the broken range, some of the outlying portions of which are quartzite, but the main mass is clay slate and conglomerate.

These clay slates outcrop in low rolling country by Egina, and in the small creeks a good deal of gold has been found, but up to the present there has been no sign of an auriferous reef. This country extends East and West, but has not been thoroughly prospected yet owing to the scarcity of water.

To the South of Egina there is a larger belt of rough broken stony ranges, the rocks of which are mostly conglomerate, the matrix being quartzite. To the S.E. of this belt of rough country there is a narrow strip of what has proved very rich auriferous country known as the Pilbarra diggings. This belt runs in a N.E. and S.W. direction, and is about 1 to 2 miles wide, lying between the granite on the East and a ridge of ferruginous quartz on the West. The reefs, although rich in patches, are so patchy and broken that they do not pay to work.

At the South end of these diggings there is an immense quartz hill, but it is not at all of a promising character for gold.

Eastward of this line of country there is a belt of intrusive granite, and then the large alluvial plains of the Yule River.

This river where crossed at Wodgina is of very great width, but has not run for many years; the water supply therefore about here is getting very short.

After crossing the Yule River the road strikes East following the river, which makes a big bend in that direction. It is about 40 miles to Mr. Look's station, and between this point and Pilbarra is one belt of granite country overlaid in the large valley of the river by recent beds of sandstone and pipe-clay resulting from the disintegration of the granite. The ranges stretch away to the North and to the South, and beyond the great table-land can be seen rising as a great flat-topped range.

Between Mr. Look's and Messrs. G. & J. Withnell's, on the Shaw or Coongan, there is a rough but nice looking belt of country. The rocks are mostly clay slate with many quartz reefs striking away to the N.E., and it is probably in the belt where the Shaw crosses it that the rich patch called the Coongan is situated.

Near the Shaw some very fine prospects of tin stone were obtained, and in most of the creeks in this and the granite country, as far as Pilbarra, traces of tin are met with.

The country about the Shaw consists mostly of large, open, alluvial and stony plains, with low ridges of quartzite and intrusive dykes striking across the country in straight lines on a bearing of N.N.E. and S.S.W.

From the Shaw the road strikes S.S.E. for about 40 miles, entering the table-land country a few miles this side of Bamboo Springs. The rocks are quartzite and basalt, with veins of chalcedony and inferior opals; the chalcedonies are often finely banded and should be of considerable commercial value, as they can be obtained in large blocks.

The country is very rough and stony along the gorge cut by the Eastern Shaw, and in the bed of this stream several fine springs break out.

Near Emu Springs the road takes a sudden turn, running away to the N.E., which direction it follows to the Nullagine, over the table-land, and then down the valley of that creek.

On approaching the Nullagine Goldfield the country changes, the table-land giving place to flat-topped hills, with here and there masses of granite, and further on clay slate hills make their appearance.

One flat spur of this table-land extends to the North on the Western side of the creek a little below the goldfield, and it is in this that the conglomerate beds are being worked.

In this conglomerate the gold is alluvial in character, but is true reef gold, being deposited there subsequently to the deposition of the boulders, between which it has been infilled with silica and iron probably by thermal action. These beds dip at an angle  $12^{\circ}$  N.W. They vary greatly in character from quartzite to boulder conglomerate, but it is only in the ferruginous beds that the gold is found.

This formation is probably of Devonian age, resting unconformably upon the edges of the clay-slates and quartzite conglomerate beds with quartz reefs of the Metamorphic series.

Another line of flat-topped hills, but lower, extends along the side of the creek, but these are of much more modern formation, and it is in these that the deep leads are met with. The beds which form these hills rest directly upon the indurated slates and are pipe-clay, soft white sandstone, gypsum and boulder beds. The wash is often very ferruginous and hard, necessitating crushing. The whole of these beds are capped by a ferruginous sandstone containing large quantities of fossil wood. To the Eastward the country opens out and large flats are met with, on some of which all trace of soil has been washed away, leaving the edges of the indurated slates with quartz reefs exposed, and it was on these flats that a good deal of gold was picked up.

Some of the reefs are worth testing, and this country is said to extend away for 40 miles to the Eastward.

## APPENDICES.

As it may be of interest, generally, to have a few particulars about the progress of other mineral fields which were not examined last year, the following is a short account of what has been done up to the end of 1890.

### YILGARN GOLDFIELD.

This field, during the last year, has settled down steadily to work, and no less than six crushing plants have been erected, besides a considerable amount of developing work done in the mines themselves.

At Golden Valley only two mines are now at work, the Kathleen and the Waterhall; neither of these mines has yet erected crushing plant, but they both have a large quantity of rich stone at grass. The Kathleen has been opened up to a depth of 80ft., and the lode is about 25ft. in width, consisting of two masses of white quartz containing mundic, one on either side of the lode, whilst the centre is composed of broken country, with small leaders rich in copper ore; the white quartz assays about 18dwts., whilst the leaders carry several ounces of gold to the ton.

The Waterhall, which is a part of the same line of reef, has been followed down on the underlay for a depth of 82ft.; a body of stone about 3ft. in thickness being worked, which yields about 2ozs. of gold to the ton.

In both these mines the lodes are well-defined, and carry gold as far as yet opened up; therefore there is every prospect of their proving payable mines.

At Hope's Hill a ten-head battery has been erected near the lake, about one mile from the main shaft, and stone is being crushed. The lode, to a depth of 82ft., is well-defined, and is about 50ft. in thickness, some portions being very rich in gold, but the whole carrying a certain amount. This large reef

carries gold at its outcrop the entire length of the two areas; and, considering the ease with which it can be worked, the quantity and richness of the stone, this mine should pay well when a larger crushing plant is erected nearer the mine. At Southern Cross there are five mines at work, four of which are crushing, the No. 1 Central Extended being the only one in which machinery has not yet been erected; but this mine is being opened up, and very good stone raised; a shaft has been sunk 104ft. The reef is well-defined, of about 25ft. in width, carrying gold all through and all the way down, but being particularly rich on both the hanging and foot walls. A trial crushing of 104 tons, taken from a depth of between 30 and 60ft., yielded 186ozs. 15dwts. of gold, and, as the stone is just as good in depth, it would pay well to put machinery on this mine. On the Central a good deal of work has been done during the last year; 2,205 tons of stone have been crushed, yielding 1,523ozs. 2dwts. 23grs. of gold, but, as this was more or less prospecting, a good deal of poor stone was crushed. The lode has now been worked to a depth of 110ft., the reef being about 25ft. in thickness, carrying gold all through, but the richer portion from two to seven feet, and about 80ft. in length, is all that has been crushed; this stone will carry about 2oz. to the ton. The latter crushings have greatly improved, being always over an ounce to the ton, and, as the stone seems to improve in depth, there is every prospect of this mine paying.

Fraser's has been extensively opened up on two reefs; the extension of the Central reef being worked to a depth of 60ft., and 180ft. in length, from which a part of the reef, varying from 4 to 10ft., is being worked; whilst a small reef at the South end has been sunk on to a depth of 100ft.; this reef, although smaller, is much richer than the former, yielding about 2oz. to the ton in trial crushings. From the two reefs, 1,776 tons of stone have been crushed, yielding 2,158ozs. 13dwts. 12 grs. of gold. To judge from this return, and the character and richness of the reef in depth, this mine may be put down as a success. Joining this area on the South side, and working in the same small rich reef, is Fraser's South mine; here the reef has been opened up to a depth of about 70 ft., where it is about five feet wide. All the crushings, up to the present, have yielded over an ounce to the ton, which must be quite satisfactory to all those concerned in it.

The Exchange reef has been opened to a depth of 110ft., the lode being from three to six feet in thickness, of a mullocky nature. A Huntingdon Mill has been erected near the lake, about two miles from the claim, and the crushings up to the present have been very satisfactory.

Five miles to the Southward another series of workings have been opened during the last year, one of which has proved to be very good; this is Blackburn's, from which 70 tons crushed yielded 129ozs. 14dwts. 12grs. of gold.

The reef is well defined, about three feet in thickness, and has been opened to a depth of 85 feet.

About 20 miles further South is Jacoletti's area, where some very rich stone was found at the surface, but in sinking this shoot has been lost.

On Parker's Range there are six claims at work, some of which have been tested to a depth of 80ft. The reefs are smaller here than at Southern Cross, and contain more mundic in depth. These areas are called Parker's, Sewell's, Toomey's, Thorn's, The Union, and Rickey's. The reefs on all these are well defined, rich, and were very showy in their caps, but up to the present no crushings have been made. A little South of this line of country are the areas called Macintosh's, Uphill's, Yilgarn, O'Driscoll's, &c.; these are all nice little reefs, rich in gold, one of which on Macintosh's area is being worked, and a crushing plant has been erected near the lake; all the stone crushed up to the present yielding over an ounce to the ton.

## KIMBERLEY GOLDFIELD.

For the following information I am indebted to the Warden.

The following mines are not at present at work—Lady Hopetoun, St. Lawrence, No. 1 North Ruby Queen, Union West, Left Rising Sun, Mount Bradley, Afghan, Crown, and Jubilee.

The stone crushed up to the end of last year was as follows:—

McNeil's, 40 tons of stone	...	351 ozs. 14 dwts.
Reform, 3 tons 3 cwt.	...	11 ozs.
Jubilee, 8 tons 18 cwt.	...	2 ozs. 2 dwts. 22 grains.
Lady Margaret, 64 tons	...	212 ozs. 7 dwts. 19 grains.
Comet, 10 tons 14 cwt.	...	134 ozs.
No. 1 North Lady Broome, 60 tons	...	4 ozs. 3 dwts.
Mt. Bradley, 414 tons	...	406 ozs. 9 dwts.
Rising Sun (about), 500 tons	...	437 ozs.
Golden Crown (about), 1,000 tons	...	900 ozs.
No. 1 North Lady Margaret, 14 tons	...	12 ozs. 3 dwts. 12 grains.
10 cwt.	...	...
No. 5 North Lady Margaret, 6 tons	...	9 ozs. 6 dwts.
10 cwt.	...	...
Faugh-a-Ballagh, 6 tons	...	6 ozs. 5 dwts.
Gladstone, 6 tons	...	3 ozs. 17 dwts.
Jackson's, 78 tons	...	56 ozs. 18 dwts.
Star of Kimberley, 1 ton	...	16 dwts.
Black Mount, 8 tons 11 cwt.	...	3 ozs. 8 dwts.
West and Left, 106 tons	...	210 ozs. 12 dwts.
Perseverance, 5 tons	...	3 ozs.
Ruby Queen (about), 2,000 tons	...	1,500 ozs.
Southern Cross, 5 tons	...	3 ozs. 5 dwts.

Where "about" is stated, no official reports have been issued.

## GREENBUSHES TINFIELD.

On the Tinfield work has also been steadily progressing, over 300 tons of ore having been sent away. Although very few areas are now at work, about as much will again be raised this wet season.

The principal areas at work are: The Dundee, J. Austin's, and Cullinan & Co's. These three are situated on an elevated portion of the country, where the vein is thin and poor, but of great extent, the tin being very coarse and often crystalline, the workings shallow; Williams' and Bishop Gibney's being along the side of Dumpling Gully, the tin being about the size of a wheat grain on the former, whilst on the latter it is finer. From these two areas a large quantity of tin has been sent away, particularly from Williams'.

A small but rich gully running through the hills towards Spring Gully has been worked by Newman, Milligan, Hughes and Jackson. The sinking on these areas varies very much in depth, according to the features of the country, and in many places it is very hard; on some of these areas the wash has been very rich, prospects yielding as much as 15lbs. to the dish.

Hart, Caporn, & Sinclair's and the Spring Gully areas are situated in the bed of Spring Gully, but is not rich until it passes through the former mentioned claim, which is lower down the stream. This is probably due to the fact that it has derived its tin from the deep lead mentioned above.

The Bunbury, which was the first discovery on the field, has done very little, for what reason it is impossible to say, as there is a large quantity of rich wash still in sight.



## THE COLLIE COAL.

This field has been opened by two shafts, the one near the range striking a 3ft. seam, whilst the one five miles further East struck 13ft. of coal, but did not go through it owing to the quantity of water met. It is a Mesozoic coal, of first class quality.

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*From the Government Geologist to the Honorable Commissioner of Crown Lands.*

SIR,—

I have the honor to forward you, herewith, the section of my Report—"The Collie Coal." I shall now start the "Greenbushes Tinfield," which I hope to be able to forward you in a day or two.

I have, &c.,

HARRY PAGE WOODWARD,

Albany, 21st May, 1891.

Government Geologist.

## THE COLLIE RIVER COAL.

### THE DISCOVERY.

About the end of the year 1889, when coal was attracting considerable attention in this Colony, Mr. David Hay, of Bunbury, became possessed of information which led him to believe that coal existed in the bed of the Collie River, at no great distance from Bunbury; for this, he set out to prospect with a party of men, and was rewarded by the discovery of some fragments of coal on the rocky bars, at the lower end of a pool; as no sign of an outcrop occurred above, it was naturally inferred that the seam was to be found in the bed of the water-hole, and as a dark patch could be seen from the bank, some men were sent into the water to dive, who brought up good samples of coal. Mr. Hay and his whole party then went in and collected coal in this way, until some hundred-weight or so was raised. This was the first sample taken into Bunbury, which was burnt publicly on the occasion of the visit of His Excellency Sir Frederick Broome.

### THE COLLIE RIVER.

The Collie River is somewhere about 70 miles in length, taking its rise in the table-land to the Eastward of the Darling Range, at about 50 miles from the coast.

For the first 35 miles of its course it flows over a sandy and swampy elevated plain, with here and there sandstone and gravelly ridges; for the next 25 miles it flows in a deep channel or gorge through the Darling Range, the rocks being all hard crystalline schists and granite.

From this gorge it emerges on the plains a little above the Collie Bridge, on the Perth-Bunbury Road, below which it flows over clay, sandy and swampy flats to its mouth.

At Australind, near its mouth, it joins the Brunswick River, and then together they discharge themselves into Leschenault's Estuary, about five miles to the North-East of Bunbury, which town is situated at the mouth of this estuary.

#### THE SITUATION OF THE COAL SEAMS.

There are two seams which outcrop in the bed of the river, the first or Western one being situated just on the Eastern side of the range, and must be very near the junction of the coal-bearing formation with the older crystalline rocks, but no junction is visible as most of the surface is covered by ferruginous sandstones and nodular clay-stones (gravel). The second seam is situated about five miles higher up the river to the Eastward, or between 20 and 25 miles nearly due East of Bunbury.

#### WORKINGS.

At the first discovery a shaft has been sunk on the edge of the water-hole; it is now full of water, but just showing above the water at the Eastern end a seam of coal is visible, overlaid by white sandstone beds. This seam also outcrops in the bed of the pool, but below the water level, and dips at an angle of about  $20^{\circ}$  to the Westward; proving that the greater elevation has taken place to the Eastward in this district since the deposition of these beds.

Two or three other shafts have also been sunk about here, but owing to the large quantity of water met with in sinking it was impossible to proceed.

At the second seam a shaft has also been sunk on the edge of the pool and which, like the first, is now full of water. In this 13ft. 7in. of coal is said to have been sunk through, but further prospecting was stopped by the large quantities of water which made in this shaft. A shaft has been sunk further from the river to a depth of 35ft., through sandstone and shale, but no coal seam has yet been met with; but this is not strange, as the seam here is dipping to the Westward, in which direction from this first shaft the new one is situated, so that when the distance and the dip are taken into consideration it will prove to be here some 50 or 60ft. from the surface.

The coal here is of a rather better quality than the first seam, which, added to the size of the seam and distance from the Crystalline rocks, would point this out as the best place to start testing the seams in depth.

#### TESTING.

It is almost impossible to sink shafts any depth in this country without pumping machinery, owing to the large quantities of water met with in depth. Therefore, the best mode of testing this field would be with a drill, which should be one suitable for sinking at least 500 feet.

#### PROSPECTS IN DEPTH.

The seams already discovered are sufficiently good to encourage further prospecting; and as coal seams very rarely occur singly, it is highly probable that many more will be met with in depth, some of which may be much better in quality.

#### QUALITY.

This coal, as will be seen from the following assays, is of a very good quality; only it is useless for gas-making, as it is a non-caking coal.

It is clean to handle, solid, and will travel well without forming much dust and smalls. It has a very high heating power when burnt in a sharp draft, but will burn slowly until all is consumed but ash, if the draft is cut off. It forms no clinkers or slag, gives off little smoke, and the quantity of ash is small; so that it should be a very suitable coal for furnace purposes.

#### ASSAY.

		1	2	3	4
Volatile	{ Water ... ..	15.20	10.87	11.70	12.75
	{ Gases, &c., ...	32.46	31.47	21.83	37.04
	{ Sulphur ... ..	2.23	2.23	2.99	0.71
Coke	{ Fixed Carbon ...	45.03	52.87	54.17	46.70
	{ Ash ... ..	5.08	2.56	9.31	2.80

No. 1 being from the first sample obtained which was from the bed of the river itself; No. 2 from a depth of 17ft. close by; No. 4 from an intermediate depth, the seam being 3ft. thick; No. 3 from a shaft 5 miles further East.

Nos. 1, 2, and 3 were made by Mr. Bernard H. Woodward, F.G.S., Government Analyst, and No. 4, by Mr. Richard Smith, Instructor in Assaying, R.S.M., S. Kensington, London.

#### GEOLOGICAL AGE.

The age of these beds is impossible to determine at present, as no fossils have yet been found, but to judge from its chemical composition it is probably an old Mesozoic coal as it is more like a lignite than a bituminous coal.

#### ASSOCIATED ROCKS.

The rocks with which it occurs are very similar to those associated with the other coal seams of this Colony, viz.:—white sandstones, ferruginous sandstones, micaceous sandstones and clays, and dark shales.

#### EXTENT.

This belt of country appears to run in a North and South direction at the back or to the Eastward of the Darling Range, though it probably does not extend very far towards the North but will probably be found to cross the Murray. To the Southward it appears to extend at first in a more South-Easterly direction, crossing the Blackwood from 10 to 20 miles to the Eastward of Jayes, and so on in the direction of the Franklin River, where it is cut off and turned to the South-West by a bold mass of crystalline rock through which this river has cut its channel.

From this point it follows down the Tone, crossing the Warren, and so on to Fly Brook, where it has been opened up.

Coal seams may not extend for any great distance over this area, but it is highly probable that they do. Anyhow, it is worth prospecting.

After crossing the Franklin at Yeriminup another belt of very similar country is met with, which extends for a distance of 20 miles; whether or not coal seams exist in this belt of country it is impossible to say, from the surface indication, until this country has been examined more in detail; but should any seams be discovered here they would be of great value, as there would be no difficulty in carrying a branch from the Great Southern Railway, a distance of 15 or 20 miles.

#### MEANS OF EXPORT.

The nearest port is Bunbury, but this harbor would have to be considerably improved before any quantity of coal could be shipped from it. The road is good

for 15 miles to the Collie Bridge, after which it has to cross the high rough Darling Range (about 1,000ft.), but no doubt a much better road could be found). There would be considerable engineering difficulties in the way of constructing a railway to the Westward, whilst there would be hardly any in making a line to the Eastward, over the Table-land, to the Great Southern Railway.

#### TIMBER AND WATER.

Timber suitable for mining purposes is in great abundance, as near the field some of the finest tracts of jarrah country in the Colony are to be met with.

As to the question of water, it is in such abundance that it will probably be a great source of trouble in deep workings.

#### THE FUTURE.

There is not the least doubt but that this will be an extensive and important field in the future, but its present development is hindered by many things—1st the great lack in this Colony of capital, and secondly, a market for the coal when raised, as the quantity that will be used in this Colony for many years to come will be too small to make a mine pay.

But both these may be overcome, as it is reported that a large and influential syndicate are in treaty with the Government for the reservation of a considerable area, which they will guarantee to test thoroughly; after which they will make a selection, paying the Government either a royalty for all coal raised, or rent for the area taken up.

This seems a very good plan, if the syndicate are prepared to give the Government a sufficient guarantee of their *bond fide* intention.

As the present holders of the land have no means to test the field, this seems (without the Government do it themselves) the only prospect of having the area tested; and without something of the kind is done this field will be like so many more properties in this Colony, simply held in the hope that it will some day be of great value, its fictitious value increasing from year to year, until it becomes quite beyond anyone's means to buy.

HARRY PAGE WOODWARD,

21-5-91.

Government Geologist.

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*From the Government Geologist to the Honorable the Commissioner of Crown Lands.*

Sir,—

I have the honor to report, in reply to your questions *re* water supply for the tinfields, that it is *perfectly unnecessary*, and that all the men now at work are *perfectly satisfied* with the supply they have; of course if the Government will supply them with a good stream of water for nothing, they will use it, but they will not pay for it, as they can all raise water so easily on their own claims.

Water conservation is next to impossible, as this is the highest point in the district.

The Blackwood, at Jayes, is 300ft. below the field, so it would have to be brought from a great distance to get it to the level of the field.

Pumping from the river is out of the question.

If anything must be done, a shaft with drives should be sunk at the 51-mile post, with an engine, from which water could be supplied down Spring Gully and Dumping Gully, one day one way, and one day the other, the sluices being arranged one below another so as to use the water over and over again.

I have, &c.,

HARRY PAGE WOODWARD,

Government Geologist.

Albany, 25th May, 1891.

*From the Government Geologist to the Honorable the Commissioner of  
Crown Lands.*

SIR,—

I have the honor, herewith, to forward you my Report on the Greenbushes Tinfield, and to inform you that I start for the Eastward on Friday, the 29th.

I have, &c.,

HARRY PAGE WOODWARD,

Government Geologist.

Albany, May 26th, 1891.

### THE GREENBUSHES TINFIELD.

*Proclaimed Area, 50 square miles.*

#### DISCOVERY.

In the latter part of the year 1888 Mr. D. W. Stinton found tin in a small gully near the road, about nine miles from Bridgetown, and 53 miles from Bunbury.

#### SITUATION.

The field is situated on the main Bunbury-Bridgetown Road, and extends South to the Blackwood River.

#### SHAPE OF COUNTRY.

The country about the field is very rough, with high hills and deep gullies; in fact, in the middle of the field is one of the highest peaks in the district.

#### PORT AND ITS CONNECTION WITH THE FIELD.

The nearest Port is Bunbury, from which a railway runs 18 miles on to the foot of the range, after which a good but hilly road connects it with the field. There is also a telegraph station on the field.

#### GEOLOGICAL FORMATION OF THE COUNTRY.

The rocks of the district are crystalline schists, gneissic, and granitic, with numerous dykes of diorite, granite, and veins of tourmaline, the surface being mostly covered by nodular clay-stones (gravel), sand, and ferruginous sandstone; the ferruginous sandstone capping all the ridges, whilst the sand is found in all the swampy hollows often associated with a poor earthy brown coal of recent formation. All the rocks strike in a North and South direction.

## WATER SUPPLY.

Although there is very little surface water on this field, except immediately after rain, there is no scarcity of it, as springs break out in several places, and it can always be obtained by sinking at a slight depth. This is very remarkable as the country is so high, and it seems to indicate that the deposits of drift are much more extensive than at present believed. There is a very large rainfall here (33 inches) which, falling on these swamps, is held for a long time, only gradually sinking away into the solid rocks below. If the trees were killed on this area the water supply would be considerably increased. The deepest shafts sunk on high ground have always struck water at from 50 to 70 feet.

During the greater part of the year the quantity of water is the great obstruction in the way of working; but if these claims were properly worked this should be taken advantage of, by raising dirt during the dry season and washing it during the wet.

## CLAIMS AT WORK.

At the present time all the claims at work are situated at the Northern end of the field, near the 50-mile post, and a little to the West of the 51-mile post in Spring Gully.

*The Dundee* (Areas marked J. M. Ferguson, Hay & Co., and D. A. Hay), the property of Mr. David Hay, of Bunbury, is being worked on tribute by Mr. Stinton and others.

This claim is situated on an elevated flat on the North side of Dumpling Gully. There seems to be no defined lead or gutter, but the tin-wash is equally spread over the surface of the rock, and is 3ft. in thickness, consisting of a sandy pipe-clay with quartz, carrying about 5oz. of tin to the dish. This wash is overlaid by from 3ft. 6in. to 4ft. of gravel (nodular clay-stones); but neither in this nor the wash is there any indication of the action of running water, the tin often being found in perfect crystals.

There is a good supply of water on this claim at about 25ft. from the surface.

The rock is a decomposed granite, very similar to the dykes worked for China clay in Cornwall, and here, as there, carries a little tin.

This claim, although not very rich, should pay well the way it is being worked.

*J. Austin.*—This area is worked by Williams and Austin, and is situated on the same flat to the North and West of the last mentioned claim.

It has been worked by means of a large *paddock*, from which 3ft. of gravel had to be removed before the wash could be worked. The wash here, which is from 3 to 4ft. in thickness, seems to be very good, yielding about 1lb. of tin to the dish; but owing to its cemented nature it is more troublesome to work, as it has either to be crushed, burnt, or allowed to weather before it can be washed. It consists of ferruginous sandstone and clay, which often contains a good deal of tourmaline and mica, with here and there pockets of sand, which are generally very rich in tin.

The tin is of a coarse and generally crystalline nature, resting on a mullocky bottom which contains a little tin.

*Cullinan & Co. and Gilbert & Co.*—Worked by Williams and Hillier. On this area the wash is overlaid by from 3 to 5ft. of yellow sand, with brown earthy coal seams overlaying from 2 to 3ft. of ferruginous sandstone, under which there is about 1ft. 6in. of wash, which carries about  $\frac{1}{2}$ lb. of tin to the dish.

The bed rock is a decomposed feldspar, with tourmaline and quartz, and it has been found easier to work in this under the wash than to strip the surface.



*R. Williams.*—This claim is situated close to the road on the South side of Dimpling Gully. It is about the best worked, and has put out more tin than any other area on the field; this is due to the fact that the owner is working it himself. The greater part of the work has been done by stripping the 4ft. of gravel which overlay the wash; but, latterly, at the Eastern end of the workings a good deal of driving has been done, as there is a good solid bed of ferruginous sandstone over the wash.

The wash varies from 1ft. to 3ft., and is often coated on the top by a black manganese stain. In this wash sandstone nodules are often met with, which are very rich in tin, and are probably derived from some older wash in the locality.

This wash runs in a line North-East and South-West, and has probably been deposited by a stream, as the lead is more or less defined.

The tin is not so coarse or crystalline generally as the previously mentioned claims, but the wash is richer and the tin more water-worn, and about the size of wheat grains. Some of the wash contains a large quantity of mica, often in large pieces but in a highly decomposed state.

The bed rock is a decomposed granite, being now a sandy pipe-clay with quartz veins. About 95 tons of tin have been raised. There is a good water supply at 7ft. from the surface.

*G. F. Moore.*—Worked by Mr. J. Greaves.—On this area, which is probably the extension of the same lead as worked on Williams', the wash is overlaid by 4ft. to 5ft. of yellow sand, consisting itself of from 3ft. to 4ft. of a mullocky wash carrying about 3oz. of tin to the dish. There is also a good deal of ferruginous sandstone, very rich in tin, but this would have to be crushed before it could be washed. The best wash follows along the North side of an ironstone ridge.

The bed rock here is a white indurated clay-slate.

*Bishop Gibney's.*—The most extensive workings on this area, and from which most tin was raised, are situated about the middle of the area on the South side of a swamp, where close to an ironstone ridge a gravelly wash carries about  $\frac{3}{4}$ lb. of tin to the dish. Further into the swamp there is about 6ft. of sand, which carries about 1oz. of fine tin to the dish. This latter should pay well to work during the wet season, as there would be no trouble in either raising or washing it, and although not rich, a great quantity could be put through in so short a time.

Further to the Westward, in a little gully, a gutter about 15ft. wide is being worked by a series of shafts and drives.

In the sinking there is from 5ft. to 6ft. of gravel, which is cemented above the wash, and here is from 1ft. to 1ft. 6in. in thickness, often containing pieces of ferruginous sandstone, very rich in tin, the whole wash yielding close upon 1lb. to the dish.

The bottom here is a sandy pipe-clay, with decomposed intrusive granite dykes.

*A. W. Newman.*—This is situated at the head of a small gully to the South of the last-mentioned, and has been worked by the means of a large paddock from which 7ft. of sand had to be removed from across the wash, which here was about 3ft. in thickness, carrying about  $\frac{1}{2}$ lb. of tin to the dish. The bottom is a decomposed granite, in which a large supply of water was struck at 50ft. from the surface.

*A. Brown & Co. (Milligan).*—This area is situated to the South and East of Newman's, on the side of the hill where a defined lead or gutter has been found under a heavy ferruginous sandstone and claystone cap, 9ft. in thickness. The wash is from 15 inches to 3ft. in thickness, on a bottom of decomposed mica rock dipping to the Westward.

The richness of this wash varies considerably, it being richest where the wash is thinnest, when it often carries 15lbs. of tin to the dish. 14 tons have been washed. This claim is being well worked, a tramway connecting the shafts and drives with the sluice.

*E. Holiday* (Hughes & Jackson).—This area is further to the South and nearer to Spring Gully. There is a nice little defined gutter, the best defined on the field, in which a nice wash is met with about 1ft. in thickness which carries about 5lbs. to the dish. It has been worked from a paddock by a drive into the side of the hill, and the dirt stacked until the creeks begin running. Washing operations will commence shortly, when a nice lot of tin will be sent in from this claim.

The bottom here is a decomposed granite, and water is at no great depth from the surface. Last winter 16 tons of tin were sent away.

*Hart, Caporn, and Sinclair*.—This area is situated in Spring Gully, to the South and West of the last-mentioned claims, the tin being probably derived from the lead which crosses Newman's, Brown's, and Holiday's blocks.

The wash occurs in the bed of the gully, and is from 1 to 3ft. in thickness, and about 20 yards in width, carrying about 1lb. of tin to the dish. In some places in the bed of the gully, very rich pockets of wash are met with, from 6 to 10ft. in depth. The wash is overlaid by surface soil, about 8 inches in depth, and is partly free sandy wash and partly clayey; this latter has to be puddled.

Water is plentiful a few feet from the surface; the creek also runs for a good part of the year.

Up to the present about 50 tons of tin have been sent away, and about as much more will be washed out this winter.

It is a wonderfully rich claim, and about the easiest to work on the whole field.

*Spring Gully Tin Mining Co.*—This area is situated to the East, and higher up the gullies; it is not being worked at present. The tin was finer, and not in such quantities as in the last-mentioned.

*D. W. Stinton & Co.*—(The Bunbury Tin Mining Co.)—This was the first discovered on the field, and is situated at the South end of the field, a little to the North of the township; when it was first opened the wash was very rich and of great thickness, but in spite of this it has never been made to pay. Tin was first found at the Northern edge of this claim, or almost at the highest point on it; work was started here, but as it was found that there was too much water to contend with in sinking, a tunnel was driven South a distance of 1,000ft., to the gullies, at a depth near the workings of 22ft. from the surface, several shafts being sunk along it to facilitate the work, and the whole being timbered.

A dam was also constructed on the top of the workings, so that it will be impossible to follow the lead of wash quite to the Northern boundary without destroying this dam.

In the large excavation worked, from which 33 tons of tin have been sent away, there is a fine wash exposed, about 20 feet in thickness, but this of course varies very greatly in richness, and is so clayey that it needs puddling; this does not seem to have been done, and the tailings would pay well to wash over again.

The best wash, which is under a false bottom of a grey clay, does not seem to have been worked, this clay evidently being taken for the bottom.

It seems to be generally believed that the first find was only a pocket, but it is nothing of the sort, but a good well defined lead which has never been traced; the tunnel to drain the workings being taken clean over the wash, which has never been prospected.

This lead comes down from the N.W., through Mr. Hay's block, under the dam, takes a sweep into the S.E., then turns away to the S.W. through a low sandy rise towards Hester's Troughs.

A good deal of prospecting has been done in a half-hearted way, without any system, and shafts have been rarely bottomed on this area.

This claim, in spite of the apparent failures, will yet prove to be one of the richest on the field.

#### PROSPECT OF THE FIELD.

Up to the end of February about 350 tons of tin ore had been sent away from this field, and it is highly probable that as much will be sent away this winter, as the claims are now being worked in a more systematic manner, and a large quantity of dirt is stacked ready for washing.

The field is quite in its infancy as yet, but nothing much will be done until more of the areas are forfeited or worked by their owners. Companies will never pay on this field, yet a handsome profit will be made by anyone who will work his own claim. This is proved beyond a doubt by all the companies closing up, whilst private individuals are doing very well, even when they have to pay a large tribute to the lessee of the area.

The best tin occurs along the lines of decomposed granite, which lines seem to run a little East of North, one line extending from Hay's and Austin's areas, on the North side of Dumpling Gully, to Spring Gully, and the other from the Greenbushes well to the township; but how much further these extend it is impossible to say until the surface gravel is removed.

The tin is probably derived from networks and strings of small leaders through this mass of decomposed granite rock, large portions of which will probably pay to work. One patch of these leaders must exist near Mr. J. Austin's claim.

This field will probably keep a good many men in work for many years, and when these veins, from which the stream tin is derived, are found, will probably become an important mining centre.

#### EXTENT OF TIN-BEARING COUNTRY.

The line of tin-bearing country extends in a North and South direction, and it has been found in places across the country as far North as the Preston River, and South beyond Bridgetown.

#### GENERAL REMARKS.

This field will never do much under the present mining regulations, as land having to be taken up in Perth stops all prospecting, for should a man be supposed to have discovered anything it is at once taken up before he can get his application in. In the next place land is allowed to be held without any labor conditions as long as the rent is paid; this, it is true, means revenue, but it is a shortsighted way of looking at it.

Stream tinfields should be worked the same as alluvial goldfields, that is, the holder of a miner's right should be able to peg out an area or claim (say) of 20 acres, which he must work, and where companies take up land they should be compelled to put on labor at the same rate.

This field has been simply killed by land-grabbing syndicates and persons who will not work themselves or let anyone else, and until they are made to realise that taking up land means liability, this will go on.

What is the use in trying to persuade outside capitalists that we have rich mineral deposits. They naturally say, "If these things are so good, how is it that your tinfields are not doing more after being worked two years"—for tin, like alluvial gold, requires scarcely any capital.

It is, pure and simple, a poor man's field, and companies will never pay; but many a poor man, if he get a chance and work hard, will not be poor any longer, as these deposits are some of the easiest to work that have ever been found, and the fine rainfall—33 inches—and the moderate depth of water from the surface, all help to make work here as easy as possible.

25-5-91.

HARRY PAGE WOODWARD,

Government Geologist.

### THE DARLING RANGE.

This range presents a bold escarpment to the coastal plains, and is composed of very hard crystalline and granitic rocks, striking North and South. At their base, on the Western side, here and there, softer rocks—such as clay-slate and sandstone—out-crop; and wherever they are met with, they contain quartz and other mineral veins.

The quartz, as a rule, contains iron pyrites in larger or less quantities, and on assay these have all proved to carry gold, but in no case rich enough to pay to work; but as only a few samples were taken, this is no test—only proving that the stone here does carry gold; and, where gold is, there is no saying when very rich “patches” may be found.

The samples collected and assayed were taken from different points between Kelmscott and the Harvey River. There are also several old lead mines along this line of country, but the galena was too “patchy” and too poor in silver to pay to work. On some of these old mines a great deal of work has been done.

The galena is associated with zinc blend and a little copper, and would require a great deal of dressing before it could be shipped.

### MICA.

For many years a great deal has been said about mica being found near Bunbury. This, at last, has taken the definite form of several claims being taken up and prospected.

They are situated on a small branch of the Collie called Bussell's Brook, on the old Albany Road. These areas are taken up by Messrs. Caporn and Timperley, who have sunk several holes a few feet, but although some fairly large mica was found at the surface this was not found in depth. This is due to the fact that the mica is contained in a granite dyke which does not go down vertically, and this must carefully be traced if this mica is to be worked.

These dykes run in a North and South direction, and are about in the same line as those on the tinfield. Near the surface, as a rule, they are much decomposed, the mica being valueless; but, in one or two places, hard masses outcrop where the mica is of a very good quality, but the rock would be too hard to work. This is probably what will be met with in depth.

As a whole this discovery is of no value without something much better is found, as the quality and quantity are not sufficiently good; but mica is so patchy that a few feet from one of the existing holes some of a very good size and quality might be found, but it is a very risky thing to put money into without there is a much better surface show.

All the country between here and the tinfield is nice looking mineral country, and tin will be probably found in many places; also between the tinfield and Jayes and Scott's, after which there is a belt of country very similar to the Collie coal and Fly Brook country, and it probably connects the two. On the Franklin River, by Yeriminup, there is another nice belt of mineral country for a few miles, after which is another belt of coal country, extending nearly to Kendenup.

25th May, 1891.

HARRY PAGE WOODWARD,

Government Geologist.

*From the Government Geologist to the Honorable the Commissioner of  
Crown Lands.*

SIR,—

I have the honor, herewith, to forward you my Report on the country examined since I last reported from Albany.

And have much pleasure in stating that I had no idea that we had either such an extent of first-class agricultural land, or that such promising mineral country existed between Albany and Perth.

The main rivers crossed deserve more attention, therefore I would suggest for your consideration that at no very distant date I be instructed to traverse these streams, both up and down, as far as I consider necessary, as there is not the least doubt in my mind that there is a large extent of tin-bearing country; and whilst upon this I might map in, roughly, the extent of the coal-bearing country which is now being tested on the Collie.

I have, &c.,

HARRY PAGE WOODWARD,

22nd July, 1891.

Government Geologist.

*Report on the Country passed over between Albany and  
Perth, including the Stirling Range, Jerramungup, the  
Gordon and Pallinup Rivers, by Harry Page Wood-  
ward, Government Geologist.*

#### THE ROAD FROM ALBANY TO PERTH.

On leaving Albany, with its bold granite hills, a belt of sandy and swampy country has to be crossed, between 20 to 30 miles wide. In this belt in several places poor brown coals have been met with, but as these are of no value, and no indication of true coal, they are not worth further consideration.

Near Mt. Barker the country suddenly changes, the sand giving place to loamy and gravelly soil, with outcrops of Metamorphic rocks, of which Mt. Barker and Mt. Barrow are composed.

A little to the South-Eastward of these hills are the bold peaks of the Porongorups, which run in an Easterly and Westerly direction, and are composed mostly of granitic rocks. From Mt. Barker to Kendenup, which is situated at the head of the Kalgan River, these highly altered rocks outcrop here and there in the water-courses; but, as a rule, on the higher ground, they are covered with ironstone gravel. This is all mineral country, and two or three mines were opened some years ago, as there are both gold and plumbago, as well as iron.

Between the Kalgan and the Gordon Rivers the country is very similar, with the exception of that between Lake Matilda and the Round Swamp, where a patch of more sandy and swampy country is crossed.

On approaching the Gordon the country opens out into large sand and clayey plains, which follow the river valley and extend across, North of the Stirling Range, to the Pallinup. To the West, rising from this plain, is Warriup Hill, and to the Eastward Sukey's Hill, and the Stirling Range with large open swampy plains to the North-East.

#### THE STIRLING RANGE.

This Range is situated in the South of this Colony, between 40 and 50 miles North of Albany, King George's Sound.

It consists of a bold range mass, running E. and W. for a distance of about 50 miles; its Western end, Sukey's Hill, being near Cranbrooke Station on the Great Southern Railway, whilst it ends abruptly at its Eastern end in one of the highest points of the range, called Ellen's Peak.

It is a striking range, seen from a distance, as it rises abruptly from a level plain, which is only about 500 or 600 ft. above the sea level at the base of these hills, some peaks of which attain an elevation of over 3,000 ft.

The range itself is a rough broken belt of country, the surface mostly being covered with stone; but, here and there, there are small alluvial flats, which are mostly sandy or gravelly.

It is intersected by numerous large deep valleys and water-courses, in which springs break out here and there, which flow so strongly during a great portion of the year as to make these streams run. But although these large streams are flooded after heavy rains, they are completely lost soon after they emerge from the hills on to the sandy plains. The geological formation is not so ancient or so highly altered as the mineral-bearing formation of this Colony, and although they have been highly folded and contorted in many places, they seem to be entirely destitute of any mineral veins or trap dykes; and although large quantities of quartz are often met with, this is of the barren nature, such as is commonly found in sandstone country, where all the small cracks have been filled in with silica in solution by the action of infiltrating water.

At the Western end of the range, near Mondinup, the rocks have been highly contorted, being folded into three sharp anticlinal and synclinal folds, in a distance N. & S. of about 10 miles, being due to the lateral compression from the Southward, where the great masses of granite seen at the Porongorup and on the South coast were intruded; but towards the Eastern end of the range the rocks have been very little disturbed, remaining in a nearly horizontal position.

The rocks here consist of a series of sandstones, more or less flaggy, often much ripple-marked, with here and there beds of a more slaty nature, and fragments of clay slate; these rocks extend from one end of the range to the other at the Western end, dipping below the surface, and appearing again; whilst at the Eastern end they are seen in one complete section of some 2,000 or 3,000 ft. It is

quite impossible to determine the age of these rocks, as up to the present no fossils have been found, but it is highly probable, from their lithological character, that they are either Devonian or Upper Silurian. At the Western end of the range, on the South side, the country suddenly changes, the underlying Metamorphic rocks with quartz reefs and dykes making their appearance; and as at several points along the Southern face of the range the surface of the plains is strewn with quartz of a very different class to that met with in the range, it is highly probable that these Metamorphic rocks extend along the South side of the range, but are mostly covered by deposits of alluvial.

The mineral prospects of the range are very slight, but in the country South of Sukey's Hill and down the Young River, and also at two or three points along the South side of the range, as far as Chester's Pass, there are good enough indications to tempt prospectors to spend both a little time and money—gold or tin being the most likely metal, but silver, copper, or lead may also occur.

As a whole this range, leaving its grand appearance out of the question, is one of the most uninteresting and useless patches in the whole Colony, as there is neither prospect of minerals being found, nor is the country of any use for any purpose whatever, as it would be difficult to find a patch of good land of more than 100 acres in extent, and as there is so much poison plant it is comparatively useless as a sheep run, whilst the timber is so small that it is of no commercial value.

#### THE COUNTRY TO THE NORTH AND NORTH-EAST OF THE STIRLING RANGE.

To the North of the Stirling Range, between the Pallinup and Gordon Rivers, is a large sandy flat with numerous salt lakes and swamps, most of which drain into the Pallinup or Salt River.

The Pallinup itself has cut its way through these soft overlying beds, exposing the crystalline schists and dykes. These are also met with in all the branch creeks crossed on approaching the river. On the higher ground, between these creeks, are level clay flats, thickly grown with marlock (malley), so dense in places that it is almost impossible to force one's way through on foot. In these malley thickets there are, here and there, perfectly clear grassy patches (often of several acres in extent), called, locally, paddocks. Here the productiveness of the soil can be judged by the fine crop of grass, and, if the malley were only destroyed in the manner adopted in South Australia, this would make fine wheat-growing land. At Magitup the country changes, here fine light and heavy red loam overlying Metamorphic rock, wooded with myall (jam), is met with, but unfortunately for this belt of country the water is more or less brackish.

To the Eastward of Magitup, up the Peenebup, this belt of light loamy country extends, with here and there, in the bed of the creek, bold outcrops of granite and other dykes. The pools in this creek are all more or less salt, but the rock water-holes are fresh. The most remarkable of these is called the "Night Well," from the fact that, when it is quite dry on a hot summer day, water can always be obtained at night. It is simply a large fissure in a granite dyke, and its intermittent nature must be due to the expansion and contraction of the rock, for, in the day time, when the surface becomes heated, the rocks would expand, closing the small crack or fissure up which the water rises, whilst when these rocks again contract, when the temperature is lowered at night, the water would again rise.

Between the head of this gully and the Gardner River is a high sandy table-land, cut here and there by deep stream beds in which the older rocks are often exposed. In one of these some stone was found which, on assay, proved to be very rich in gold, but owing to the small size, irregular course of the veins, and hardness of the rock this would scarcely pay to work. This rock is a large diorite dyke, with small veins of a greenish quartz containing a little iron pyrites intersecting it, the largest of which is only a few inches in thickness; but one thing,



gold is there, and when gold is once found it is worth further prospecting, as it is not as if only a trace had been found, for the stone that was assayed yielded oz. of gold to the ton.

This belt of country would be also worth prospecting for tin, as the rocks and wash are both very similar to the tin-bearing country in other places.

At Jerramungup, on the Gardner River, there are large outcrops of granite, which is evidently the Southern extension of the great line of dykes which extend as far North as the Murchison River.

To the Northward of this country stretches the great sandy table-land of the interior, with its salt lakes or clay-pans, and isolated bare granite hills, whilst to the South are sand-plains, through which the rivers have cut large deep valleys bounded by sandstone cliffs exposing the underlying Metamorphic rock in these beds, where often large quantities of quartz are met with which should be prospected.

#### THE GORDON RIVER BETWEEN THE ALBANY ROAD AND YERIMINUP.

For twenty miles down the Gordon River from the bridge the river flows over large alluvial plains, mostly of a clayey nature, with a series of large permanent pools or water-holes in its bed. But, from a little below Wonerup on to its junction with the Frankland River, the country suddenly changes, the Metamorphic rocks suddenly outcropping and closing in upon the river.

The rocks are gneissic and granitic, with numerous reefs and dykes; and it is, in fact, a typical patch of mineral country, although much of the surface on the higher ground is covered by limestone gravel. This is often of no great thickness, especially in the gullies, where all prospecting operations should commence.

The land about the junction of this river, and down the Frankland, amongst the hills, is very good, consisting of a rich red loam, sometimes a little gravelly, highly suited to vine and fruit growing, as seen at Mr. Warburton's, where some of the finest fruit ever grown in this colony is produced.

About 5 miles to the South of the Gordon a belt of Metamorphic runs in a South-Easterly direction towards Warinup Hill, which is probably the Western extension of the country seen at the head of the Young River, which crosses the railway line near the Round Swamp.

This country is a good deal covered by gravel and other surface deposits, but would be worth prospecting, as also would the country along the Frankland River, as it is very similar to the tin-bearing country at Bridgetown.

#### THE GORDON RIVER TO THE NORTH-EAST.

For a few miles in a North-Easterly direction the Gordon River flows over open clay flats with swamps here and there, but higher up, where the older rocks again outcrop in its bed, the country greatly improves, these sticky clays and sands being replaced by rich loams. All the country around Eticup, which is near its head, has long been settled by farmers, as there is a great extent of land fit for agricultural purposes, but up to the present this has only been worked on a small scale owing to the expense of carting; but now that the railway passes within a few miles, this will rapidly become a great wheat-producing district.

Some little time ago a great deal of excitement was caused by the reported discovery of rich gold-bearing stone, supposed to have been found by one of the men employed in sinking a tank on Lord Brassey's estate (Coblup), but as he afterwards denied that it came from the tank, but said he would show the place if a certain sum were paid him, the matter dropped; but as several persons still believe in the truth of the statement, it was considered advisable to thoroughly examine the district to determine whether any stone of a similar character existed

there. The specimen is of a granular ironstained quartz, rich in gold, very similar to the stone found at Kimberley near the surface, but no stone of this class exists about the head of the Gordon or Pallinup Rivers, where all the quartz is whiter and much more glassy and crystalline. The rocks are highly altered with numerous granite and other trap dykes, and large masses of quartz often forming low hills or ridges across the country, but these, as a rule, are not of a promising character.

In some places, where tanks and wells have been sunk, large deposits of pipe-clay, with small quartz grit through it, have been met with. These deposits are very common in all mineral-bearing country, as the decomposition of the mineral sulphides in the lodes acts chemically upon the adjoining rocks; or in other cases, where there are coarse-grained granite dykes with tin veins, we often find the feldspars have decomposed, forming China clay, but the quartz still remaining in angular fragments intermixed.

This country would be certainly worth prospecting, both for tin and gold; for, although the specimens brought in were not found there, reefs of a different character carrying gold may be found.

#### THE HEAD OF THE PALLINUP RIVER.

The country at the head of the Pallinup River is very similar in character to that at the head of the Gordon, but if anything is rather better; but then it has the drawback of not having such a good rainfall. This, all along, has been the drawback to settling this country, for, as a rule, wherever wells have been sunk they have proved to be brackish, the exceptions to this rule being one or two small surface soakages which were long ago taken up as small blocks, such as Nigalup. The rocks are mostly crystalline, with dykes of granite and diorite, and in some of the tanks sunk on Martinup, decomposed (mullocky) granite, identical with the tin wash at Bridgetown, and very similar to that in Cornwall, has been struck. This country would be richly worth prospecting for tin, as it has every appearance of being a tin-bearing country.

The question of Artesian water has been raised for this district, but this is quite out of the question, for where these highly broken Metamorphic rocks outcrop, if there were an underground water supply, under sufficient pressure to rise to the surface up a bore, it would find its way to the surface now by means of the fissures which exist in the rock.

The best thing is to sink tanks and ring the trees, and if hard bars of granite cross the water-courses, wells may be tried on the higher side of these, but neither the supply nor the quality can be depended on.

#### THE GORDON TO KOJONUP.

The road crosses the low ridge between the Gordon and Slab Hut Gully, which latter stream it follows up, crossing the water-shed between it and the Balgarup, which is a tributary of the Blackwood River. This is all promising mineral country, and in several places very nice quartz reefs are visible.

Between Kojonup and the Beaufort River there is a poor sandy patch of land, but, on approaching the river, good land is again met with. This river and the Arthur are the main branches of the Blackwood River, and wherever rock outcrops, which it always does in the valleys, it is of a most promising mineral character.

#### THE WILLIAMS AND HOTHAM.

These are the two main branches of the Murray River, and along their valleys there is a large extent of good land, with outcrops of Metamorphic rocks, with mineral veins and dykes. Near the Williams a deposit of Manganese is reported to have been found, but, up to the present, although the country richly deserves it, very little prospecting has been done.

## THE HOTHAM TO NARROGIN.

This portion of the road passes over the Darling Range, where the hard crystalline rocks, similar to those met with throughout the entire length of this range, are met with. They are, in most places, on the high ridges, capped with ironstone gravel and conglomerate, and where the rocks do outcrop in the water-courses they are not of a mineral-bearing character. The land is mostly poor, being thickly covered by jarrah, with some patches of red-gum in the small flats.

## NARROGIN TO PERTH.

Near Narrogin there are some small but rich flats in the valleys, and the rocks, as a rule, along this Western face of the range, are less hard, slate outcropping in places with quartz veins, which carry a good deal of mundie, and more or less gold. It was near here that a small mine called the "Two Wonders" was opened up some years ago, but the stone was not found rich enough to work; but the fact still remains that gold is there, and there is not the least doubt that richer deposits will be found when the country is more systematically prospected.

The land at the foot of the range, and up these small creeks, is wonderfully suited for garden and orchard purposes, as the soil is rich, water plentiful, and there is no frost to speak of.

From Narrogin to the Northward, the road follows the Canning River, passing over large clay flats, but after crossing the bridge it ascends the low sandy spur which separates this valley from the Swan.

## CONCLUSION.

As a whole, throughout this trip, it is surprising how much good land there is both for mineral and agricultural purposes; and one cannot be far wrong in predicting that, before many years, a large farming and mining population will be settled along all the main valleys between Albany and Perth.

HARRY PAGE WOODWARD,

Government Geologist.

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