MINING HANDBOOK

TO THE COLONY OF

WESTERN AUSTRALIA,

Written especially for Prospectors and Strangers to the Colony who are interested in Mining,

BY

HARRY P. WOODWARD,

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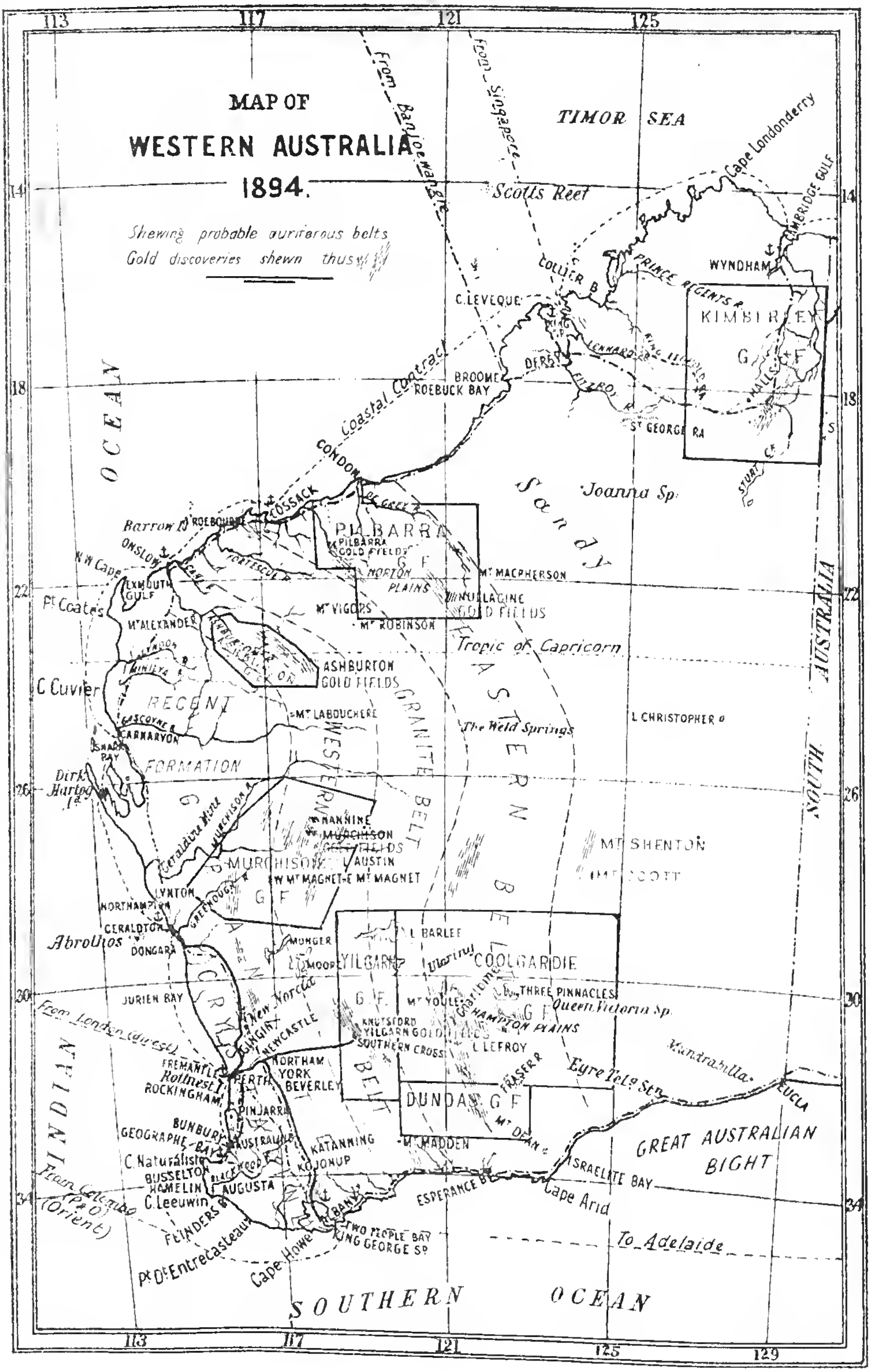
GOVERNMENT GEOLOGIST,

BY AUTHORITY OF

THE COMMISSIONER OF CROWN LANDS.

PERTH:
BY AUTHORITY: RICHARD PETHER, GOVERNMENT PRINTER.

1894.


MAP OF
WESTERN AUSTRALIA
1894.
Shewing probable auriferous belts
Gold discoveries shewn thus
TIMOR SEA
Scotts Reef
Cape Londonderry
CAMBRIDGE GULF
WYNDHAM
KIMBERLEY
G F
COLLIER B
PRINCE REGENTS R
C. LEVEQUE
DERBY
BROOME
ROEBUCK BAY
FITZROY R
ST GEORGE RA
Coastal Contract
From Banjoewangie
From Singapore
OCEAN
CONDON
COSSACK
ROEBOURNE
Barrow Id
ONSLOW
N W Cape
EXMOUTH GULF
Pt Coates
PILBARRA
PILBARRA GOLD FIELDS
G F
NORTON PLAINS
NULLAGINE GOLD FIELDS
MT MACPHERSON
MT VIGORS
MT ROBINSON
FORTESCUE R
MT ALEXANDER
ASHBURTON GOLD FIELDS
C Cuvier
RECENT
FORMATION
GASCOYNE R
CARNARVON
Dirk Hartog Id
MT LABOUCHERE
Sandy
Joanna Sp
Tropic of Capricorn
EASTERN BELT
GRANITE BELT
WESTERN
The Weld Springs
L CHRISTOPHER
SOUTH AUSTRALIA
NANNINE
MURCHISON GOLD FIELDS
L AUSTIN
W MT MAGNET
E MT MAGNET
MURCHISON
G F
MT SHENTON
MT SCOTT
Geraldine Mine
MURCHISON R
LYNTON
NORTHAMPTON
GERALDTON
Abrolhos
DONGARA
MONGER
L MOORE
YILGARN
G F
L BARLEE
COOLGARDIE
G F
THREE PINNACLES
Queen Victoria Sp.
HAMPTON PLAINS
L LEFROY
KNUTSFORD
YILGARN GOLD FIELDS
SOUTHERN CROSS
JURIEN BAY
New Norcia
GINGIN
NEWCASTLE
NORTHAM
YORK
BEVERLEY
FREMANTLE
Rottnest I
PERTH
ROCKINGHAM
PINJARRA
BUNBURY
GEOGRAPHE BAY
C. Naturaliste
BUSSELTON
HAMELIN
C. Leeuwin
AUGUSTA
BLACKWOOD R
KATANNING
KOJONUP
ALBANY
DUNDAS G F
FRASER R
MT DEAN
MT MADDEN
ESPERANCE B
ISRAELITE BAY
Cape Arid
Eyre Telg Stn
Kundrabilla
EUCLA
GREAT AUSTRALIAN BIGHT
To Adelaide
From London (direct)
From Colombo (P&O) (Orient)
INDIAN
FLINDERS B
Pt D'Entrecasteaux
Cape Howe
TWO PEOPLE BAY
KING GEORGE SD
SOUTHERN OCEAN
113
117
121
125
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CONTENTS.

Geologically Coloured Map.

PREFACE.

Since the year 1887 I have spent most of my time in travelling about this Colony, and so have come in contact with most of its inhabitants, who, almost without exception, seem to be urgently desirous of information about its mineral resources, and the same is the case with the numerous visitors who call upon me, while every mail brings letters from intending visitors and speculators making inquiries on the same subject. My first annual report, published in 1890, which is the only general geological description of the Colony, has been in such demand that it has long been out of print; I have therefore attempted, in this little work, to supply what I considered to be a general want, namely, a general report on the geography, geology, and mineral resources of the Colony, with a little mineralogy, and such other information as may be useful for the guidance of visitors, prospectors, and settlers generally. I have not written it as a scientific treatise, but have tried, as far as I could, to make the information it contains as simple as possible to bring it within the understanding of persons who have had no scientific training.

This being the first attempt at a work of this description in this vast Colony, there must naturally be many imperfections and omissions. I will therefore ask my readers to deal leniently with it, and should it prove serviceable in any way to them, my object will have been attained. Should a future edition be considered necessary I will try to greatly improve upon this one, and to this end I shall thankfully receive any suggestions, criticisms, or corrections.

H. P. W.

1-3-94.

GENERAL.

POLITICAL AND PHYSICAL.

Position.—Western Australia includes all that portion of the Australian Continent situated to the westward of the 129° East Longitude, including all the islands adjacent in the Indian and Southern Oceans.

Area.—The greatest length of this territory, from Cape Londonderry, in the North, to Peak Head (South of King George's Sound), in the South, is 1,450 miles; and its breadth from Steep Point, at the South of Dirk Hartog's Island, on the West, to the 129th Meridian on the East, about 850 miles. It contains an estimated area of 976,000 square miles, being about nine times the size of the United Kingdom, or equal in size to all the following European States joined together:—Austro-Hungary, Belgium, Bulgaria, Denmark, France, Germany, Greece, Spain, Turkey, and Roumania. Thus it is the largest of the Australian Colonies, occupying about one-third of the whole continent.

Western Australia was originally known as the "Swan River Settlement;" this name, however, only applied to the South-West corner of the Colony. The settlements of the Colony lie in patches along the coast between Albany (King George's Sound), in the South, and Wyndham (East Kimberley), in the North, being scattered over an area of about 1,200 miles in length, from North to South, by about 150 miles in average breadth. Inland settlement is, however, being rapidly extended.

The Colony was first permanently settled on June 1st, 1829.

Population.—The total population of Western Australia (exclusive of aborigines) appears at the taking of the Census upon April 5th, 1891, to have been 49,782 persons, composed of 29,807 males, and 19,975 females, of which 918 were Chinese. It is now, however, estimated at something over 65,000.

Constitutional.

On the 21st October of the year 1890, Sir W. C. F. Robinson, G.C.M.G., arrived in the Colony, and proclaimed the new Constitution on the 22nd. The Constitution thus secured provides a Parliament composed of two Houses, described respectively as the Legislative Council and Legislative Assembly, both of which are elected by the people.

Principal Towns.

Albany is situated on the North side of Princess Royal Harbour, off King George's Sound, about 254 miles by road and 352 miles by rail from Perth. It has the finest harbour in the Southern portion of the Colony, and is, therefore, made use of as a port of call by the mail steamers from Europe.

The town is growing rapidly since the opening of the Great Southern Railway. It is fortified with the idea of making it an Imperial naval coaling depôt.

Beverley is a small township on the Avon River at the junction of the Eastern Railway and the Great Southern Railway, being 110 miles from Perth. It is the centre of an agricultural district, but has received a great impetus from the railway passengers, as all trains (with the exception of the mail, which runs once a week) stop the night here.

Bridgetown is situated on the Blackwood River, about 55 miles by road from Bunbury. It was purely an agricultural centre until some three years ago, when stream tin was discovered about eight miles distant. It is connected by telegraph with Bunbury, and a coach runs from that town twice a week.

Broome is a small town on Roebuck Bay, on the North coast. It is the principal centre of the pearling industry, being the most central and safest harbour for the fleets to lie in during the hurricane season. The cable to Banjoewangie also starts from here, and the town is connected with Perth by telegraph.

Bunbury is a small port on the Western coast about 107 miles South of Perth, with which it is connected by telegraph, and the South-Western Railway. It possesses the great advantage of good land, combined with a large rainfall. It is the port for the tinfield, and a coalfield has been discovered about 30 miles distant on the Collie River.

Busselton is a small township on the South-West coast, about 30 miles South of Bunbury, and like that town is surrounded by some very good land. It will shortly be connected with Perth by the South-Western Railway.

Carnarvon is situated at the mouth of the Gascoyne River, and is the port for the Gascoyne district, where the principal pursuit is sheep farming.

Cossack is the principal port of the North-West. The port is known by many names—as Port Walcott, Cossack Roads, Tien Sin, Nichol Bay, etc.—which is apt to cause considerable confusion. It is connected with Perth by a telegraph line, and with Roebourne by a tramway, eight and a half miles long.

Derby is situated in the Kimberley District, near the mouth of the Fitzroy River, at the head of King's Sound. It has a fine natural harbour, from which the wool and cattle produced in this district are shipped. It is connected with Perth by a telegraph line.

Dongarra is a small port at the mouth of the Irwin River. A fine piece of agricultural land runs up the river, and a good deal of wool is grown further inland. It is connected with the capital by telegraph, and with Geraldton by the Midland Railway.

Eucla is a small township on the shore of the great Bight, close to the South Australian border, and it is here that the two colonies' telegraph lines join. There are a few sheep stations near.

Fremantle is the principal port of the Colony, being situated at the mouth of the Swan River, about 12 miles from Perth, with which it is connected by road, railway, steamboat, telegraph, and telephone service. The Harbour is very exposed to gales from the North-West, but this defect will shortly be overcome, as the mouth of the river is now being opened up and a breakwater being constructed, which will enable ships of any size to lie protected in deep water.

Geraldton, also called Champion Bay, is situated in the Victoria District, a little over 200 miles North of Fremantle, and it is the principal port in the North. Its exports are: wool from the Murchison District; copper and lead from Northampton; and wheat from the rich agricultural flats of the Greenough, which lie immediately to the eastward of the town. It has always been a thriving little town, but latterly it has received an additional impetus from the discovery of the Murchison goldfield. A railway line connects it with the mining district of Northampton, and two lines are being constructed, one to Perth, which is 295 miles distant, and one to Mullewa, 70 miles on the Murchison road.

Gingin is a small township, about 50 miles to the North of Perth, and the Midland Railway, which will connect Perth with Geraldton, passes through it.

Guildford is a small suburban town, at the junction of the Swan and Helena Rivers, 9 miles East of Perth, with which town it is connected by road, the Eastern Railway, and telegraph.

Katanning is a new township, about half way between Beverley and Albany, on the Great Southern Railway. It has made great strides, owing to the energy of its principal merchant, and now bids fair to become one of the most important inland towns.

Newcastle is a small agricultural town, on the Avon River, about 50 miles East of Perth, with which it is connected by the Eastern Railway, road, and telegraph. The district is called Toodyay, and has some of the finest patches of land in the colony, being admirably suited to the growth of fruit and grapes.

Northam is another small town on the Avon, about 18 miles South of Newcastle. It is also connected with Perth by rail (the Eastern Railway), road, and telegraph. Like the last mentioned district, the land is highly suitable for agriculture. This is the starting point of the Yilgarn Railway line, which is now under construction.

Northampton is situated in the heart of the copper and lead mining district, about 30 miles north of Geraldton, with which it is connected by the Great Northern Railway. It was once a flourishing town, but owing to the fall in the value of lead and copper, the mines have mostly stopped work, and it is now almost deserted.

Perth, the capital of the Colony, is situated on the banks of the Swan River, about 12 miles in a North-Easterly direction from the port of Fremantle.

Pinjarrah is a small town about 54 miles South of Perth, on the River Murray. The South-Western Railway from Perth to Bunbury touches here.

Roebourne may be considered as the capital of the North-West, and will probably be so when a form of local Government is introduced. There are some very large sheep stations in this district; also the Pilbarra and Nullagine goldfields.

Southern Cross is the principal town on the Yilgarn goldfield, and is connected with York by road and telegraph line, and a railway is now under construction from Northam. It is the official centre of the field.

Wyndham is at the head of Cambridge Gulf, and is the port for the Kimberley Goldfield, and for the shipment of cattle.

York is at present the principal town in the Eastern Districts. It is on the Avon River, between Northam and Beverley, on the Eastern Railway, and about 60 miles by road from Perth. The telegraph line starts from here to the Yilgarn goldfield, also the new road.

Physical Geography.

Western Australia is bounded on three sides by water, the Northern and Western coasts being washed by the Indian Ocean, and the Southern by the Southern Ocean.

Coast Line.—The coast line, which is about 3,500 miles in length, has long stretches little broken by bays, gulfs, or creeks, and so is very short for the size of the country. The coast is rising rapidly, which accounts for the low alluvial sandy plains occurring between the sea and the ranges. These plains vary from a few hundred yards to twenty miles in width, and are interspersed with numerous estuaries, lakes, and swamps.

Tides.—There is a great variation in the rise and fall of the tides along the coast of this colony. On the South and South-West coast, as far North as Sharks Bay, there is no tide worth mentioning, but directly Cape North-West is passed, the rise and fall is considerable, being 18ft. at Cossack, 36ft. 6in. at Roebuck Bay, 46ft. King's Sound, and 20ft. at Cambridge Gulf.

Bays, Gulfs, and Inlets.—The coast is sadly deficient in good harbours; the only ones deserving mention are King George's Sound, Cockburn Sound, Champion Bay, Sharks Bay, King Sound, and Cambridge Gulf; the remainder being of no use, as they are exposed to prevalent winds and currents, and are too shallow, have bars at their mouths, or the outlying dangers are too great.

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

Islands.—The North and South coasts are fringed with numerous small islands; but the only two on the coast of any size are Dirk Hartog's Island, off Sharks Bay, and Rottnest, off Fremantle. Guano is found on the islands comprised in Houtman's Abrolhos, and various islands to the North, including the Lacepedes.

Mountains.—The mountains are not remarkable for their height, though many of them, rising abruptly from plains, present a rather striking appearance. The principal ranges in the South-West are the Darling, Roe, and Blackwood Ranges. The Darling Range is the most important, extending almost due North and South from Yatheroo at the North, to Point D'Entrecasteaux at the South, a distance of about 300 miles, and following the coast about 18 to 20 miles from the sea, towards which it presents a steep face. There are no peaks over 1,500 feet in height, yet as it rises abruptly from the low coastal plain, it has a more imposing appearance than the Roe Range, which runs parallel to it further to the Eastward, of which the highest peak, Mount William, in the Murray district, attains an elevation of 3,000 feet above sea level. The other range, the Blackwood, has the greatest average elevation, although it does not anywhere attain a greater height than 2,000 feet. About 40 miles to the Northward of Albany, on the South coast, is the Stirling Range, which is the loftiest range in the settled districts, and being perfectly isolated, and rising abruptly from a large plain, it is visible for an immense distance. Its chief peaks are Mount Toolbrunup (3,341 feet) and Ellen's Peak (3,420 feet). In the North of the Colony, in the Kimberley District, is the King Leopold Range, which attains an elevation of between 2,000 and 3,000 feet.

Some of the highest hills and ranges in the Colony are said to exist in the Northern portion of the interior, at the sources and upper part of the basins of the large rivers. They have not yet been accurately measured, though they are estimated to reach the height of 6,000 or 7,000 feet above the sea level; but as they rise from high ground, the country at their base often being as much as 2,000 feet above sea level, they do not present such a grand appearance as would be expected.

No volcanoes exist in any part of the Colony, though the craters of extinct ones are reported to have been discovered in the North and North-West. The general appearance of the country throughout indicates a condition of remarkable quiescence even further back than the carboniferous epoch.

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

Lakes.—The lake district may be considered to be confined to the low coastal country; within this area there are numerous salt and fresh water lakes and lagoons. The maps show a great number of lakes in the interior, which tend to give a very incorrect idea of the country, as, except after heavy rains, when they may be covered with a few inches of water, they are mostly dry, being in reality nothing but immense salt clay pans or marshes.

The Climate cannot be spoken of as a whole, owing to the enormous extent of the Colony. In the Kimberley District there is a truly tropical climate. The wet season ranges between December and March, occasionally continuing into April.

The heat during these months is extreme, but once over, the climate is excellent, particularly on the table-lands of the interior.

During the summer the North-West coast, between Ashburton and Roebuck Bay, is subjected to visits of cyclonic storms, accompanied by heavy rains (locally called willy-willies) which are a source of danger to life, stock, and property. The heat, although often excessive, is for the most part a very "dry heat," and the settlers from there often complain that the heat in the Southern part of the Colony, at a far lower temperature, is much more trying.

In the Gascoyne and Murchison Districts there is a better rainfall than on the North-West coast, most of it inland falling in good heavy summer showers, with a fine healthy dry climate for the rest of the year, but nearer the coast there is also a fair winter rainfall.

Extremely heavy dews make up to a great extent for the apparent lack of winter rains; and the great heat occasionally experienced is tempered by strong cool breezes.

In the South-West settled portion, the seasons may be divided into wet and dry, the former lasting from April to October, and the latter November to March; during the summer heavy thunderstorms may occur, but are most uncertain and very local. The climate in this portion of the Colony is unrivalled, being temperate and cool, with a fine rainfall, as is evidenced by the magnificent Jarrah and Karri forests, and by the abundance of the fruit and other crops produced. The annual rainfall on the coast, from Fremantle to Albany, is about 40 inches, whilst the temperature rarely exceeds 100° in summer, or falls below 35° in winter. Fifty miles inland, among the ranges, the rainfall does not exceed 20 inches, whilst further Eastward the climate is drier, but the soil still appears to receive a fair rainfall; little accurate information has, however, yet been obtained, settlements having only lately spread out any distance in this direction.

The settled districts are mostly level or undulating, the South-Western seaboard being comparatively flat, of a sandy character, with numerous inlets and swamps, with indications of a recent geological formation; whilst to the Eastward of the Darling Range, in the latitude of Perth, the country changes in character, and generally improves as you proceed inland. With the exception of a few sand plains, the whole of the uncultivated country of the Southern part of the Colony may be said to be one vast virgin forest principally timbered with Jarrah, Karri, Red and White Gums.

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

Soil.—In this Colony there are as good and as great a variety of soils as in any part of the world. Unfortunately only small portions are as yet under cultivation, for large tracts of the best land, where there is a sufficient rainfall, are either heavily timbered or held by persons who do not cultivate.

The most sandy country is capable of producing the finest fruits and vegetables.

Cereals are grown as far North as 29° South latitude, and in the Eastern districts it is not uncommon for a crop to yield as much as from 20 to 30 bushels to the acre.

Water Supply.

The settled districts of this Colony are well watered, as is proved by the fact that up to the present very little has been done in the way of water conservation, the settlers depending almost entirely upon natural waters.

In the Northern or pastoral districts there are large pools in the beds of the rivers, which are, as a rule, annually flooded; or water can be obtained by either scratching in the sand of the beds, or by shallow sinking on the flooded plains. As the stations are almost entirely worked with native labour, it will give some idea of the ease with which water can be obtained, when it is stated that one native mostly can water his flock (of about 1,000) with a bucket and rope.

Many of these shallow water supplies have been opened up in the Murchison district (where stations have gone in for fencing) so that the sheep can water themselves. Further to the eastward, at such places as the Yilgarn goldfields, the water supply has been the great trouble, as most of the country is salt. The water is not only salt in the ordinary sense, but is almost charged to saturation. Numerous wells have been sunk, and small supplies of fresh water met with in places, but this brine was always met with at about the same general water level, and as it is a broken country, with numerous reefs and dykes, and the rocks dip almost vertically, there is no prospect of sinking through this salt stratum. The best means, therefore, of obtaining fresh water, will be by constructing large dams to conserve the rain water thrown from the large granite hills, and by erecting condensers. In one or two places small local soakage of fresh water has been obtained, but these have not proved to be at all permanent.

This district remaining salt is due to its physical features, as this tract is comparatively flat, with no large rivers to drain off the water, which has dissolved the salt out of the ground. It is certainly true that after several good seasons, many so-called springs of fresh water break out around the granite hills; but it may, as a whole, be called an almost waterless country, and this class of country extends to the border of South Australia.

Timber.

This country is splendidly timbered, the different classes of trees being met with in belts following pretty closely the same lines as the rainfall. Thus the Karri (Eucalyptus Diversicolor) is met with along the South coast, from the South-West corner to a little Eastward of Albany.

The Jarrah (Eucalyptus Marginata) and Red Gum (Eucalyptus Calophylla) form the next belt, which runs in a South-East direction from a point about 100 miles North of Perth, to the South coast.

The whole of the South-West portion of the Colony may be considered as one immense forest, whilst the timber extends in patches for 300 miles inland to the Eastward of Perth, where, in the rich alluvial flats around the salt lakes, extensive forests of Morrell, White Gum, and various Malleés are met with.

In the North, trees of any size are only met with along the sides of the large water courses, but here they are generally plentiful, and of good size.

Baron Sir Ferd. Von Mueller, K.C.M.G., in the introduction to his "Report on the Forest Resources of Western Australia," writes:—

"The forest-regions of extra-tropic West Australia occupy an area equal to the whole territory of Great Britain; and it is singularly fortunate for the Colony that over this vast extent of wooded country a species of Eucalyptus (the Jarrah) prevails, which for the durability of its timber is unsurpassed by any kind of tree in any portion of the globe. Under such circumstances the timber resources must be regarded as among the foremost in importance throughout the wide tracts of West Australia, even if the many other kinds of utilitarian trees, occurring in the more Southern portion of that colonial territory, and the still more varied sorts of timber-trees, to be found within the intra-tropic regions of West Australia, were left out of consideration."

"It is furthermore of particular advantage to the Colony that its highly valuable Jarrah-timber is obtainable through at least five degrees of geographic latitude, and this within so short or moderate a distance of shipping places as to render it easily accessible to foreign traffic."

The forest area, South of the tropics, is included within the parallels of South latitudes 31° to 35°, but very little good timber of any size is found nearer the coast than five to seven miles. As a fact, it may be stated that a belt of forest land exists between the latitudes above mentioned, in some places extending inland for 100 miles, but the best jarrah wood is found in the hill ranges, and not nearer than 15 or 20 miles from the coast, and of this the areas occupied by the principal Eucalypti are:—

	Square miles.
White Gum or Tuart (Eucalyptus gomphocephala) ...	10,000
Jarrah (Eucalyptus marginata)...	14,000
Karri (Eucalyptus diversicolor)...	2,300
Red Gum (Eucalyptus calophylla)	800
York Gum (Eucalyptus doxophleba)	2,400

The White Gum grows generally in all forests, excepting in that part of the Colony where Karri abounds. It is, however, found in the greatest profusion Eastward of the Darling Range. The wood is used for many purposes in the Colony, being as good for resisting dry-rot as Jarrah, but it does not appear as an article of export.

GEOGNOSY.

A GENERAL DESCRIPTION OF THE COUNTRY.

The Kimberley District.

The whole of the country, North of a line which runs in an Easterly direction, from the Eighty-Mile Beach to the borders of the Northern Territory of South Australia is called the Kimberley district.

To the Eastward and South-Eastward of King's Sound, large undulating plains of alluvium, sand, and sandstone gradually rise towards the Leopold Ranges. These plains are broken here and there along the Fitzroy River by low hills of sandstones, grits, and conglomerates of Carboniferous age, but the main portion is mapped by Mr. Hardman as Tertiary.

The Leopold Range is formed of the oldest rocks known in the district, viz:—quartzites, altered grits, schists, and gneiss, flanked on the South-West face by limestones, which are often Magnesian, of Carboniferous age; it runs in a North-West and South-East direction, attaining an elevation of from 1,500 to 2,000 feet above the sea level.

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

From the Margaret Plain, which is 300 feet above sea level, the country rises rapidly towards the Albert Edward Range, which is formed of Devonian rocks, in which some peaks attain an elevation of 1,170 to 1,650 feet. Between the Margaret River and this range are a series of slates, grits, and sandstones, which in places form lines of hills that are intersected by numerous quartz reefs, many of which are rich in gold.

To the Eastward are a series of undulating hills, with here and there a rough face of rock or a deep well-marked valley extending as far as the eye can reach. This is called the Great Antrim Plateau, and is of great interest, as it is the only known lava flow in West Australia.

Both to the North and South of this table-land the Devonian and Carboniferous rocks are well developed, but on following the Ord River further North the Metamorphic rocks again outcrop, following the river in a North-Easterly direction to the Burt Range, where they disappear beneath the Carboniferous formation, which extends as far as the coast, and all the way down it from Cambridge Gulf to King Sound.

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

The North-West District.

This district extends along the North-West coast, from Point Cloates to the 80-Mile Beach, and Eastward to the boundary of the Northern Territory of South Australia. At the heads of the Fortescue and DeGrey Rivers, there is a high table-land of carboniferous age with numerous basalt dykes.

Several large rivers take their rise on this table-land, flowing in a Westerly and North-Westerly direction, cutting deep gorges through the horizontally bedded carboniferous rocks, exposing the underlying crystalline series. Further on they pass over flats, bounded by rough sandstone ranges, and so on by deep ravines through rough broken hills of schists, slates, sandstones, quartzes, conglomerates, with numerous amygdaloid dykes and quartz reefs, many of which have proved to be auriferous.

These rivers next flow over the large alluvial plains of the coast, rising from which here and there are bold hills of trap rock and small peaks of quartz, granite, and ironstone, around which soft calcareous slates are often met with, rising to the surface, but never forming hills much above the level of the plains.

These plains extend to the sea coast, where they are fringed by mangrove swamps, except where trap rocks extrude and form a bold rocky coast.

The amygdaloids in many places split up into rough blocks, which become red or black on the surface, and then present the appearance of a huge heap of stones, without a trace of soil or vegetation. They contain vast numbers of agates, calcite crystals, and other enclosures, so that it would be advisable to prospect the streams running through them, for precious stones.

Further to the Westward the rivers are not so large, rising in a range which runs North-West and South-East, forming the water parting between the rivers flowing West and those flowing North. This range is formed of crystalline rocks, capped with horizontally bedded sandstone. It presents bold cliffs to the open plain or lower table-land lying to the North, which is occasionally broken by isolated sandstone hills often containing jasper and agate, while the rivers expose beds of conglomerate and breccia beneath the sandstone. Below this tableland the country is more broken, covered with small ranges and isolated hills, capped with sandstone, between which the rivers open out into good sized flats. The coast ranges, rising about 700 feet above the sea, are rough broken hills, composed of hornblende schists, quartzite, conglomerates, shales, limestones with amygdaloids, diorite, granite, actinolite, and tourmaline dykes, and lodes of galena, auriferous antimony, ferruginous copper ore, ironstone, quartz, and jaspery veins.

These hills are generally separated from the coast by large alluvial plains, intersected here and there by quartz reefs (as at Mallina) and huge outcrops of rock, forming a bold rocky coast, as at Cossack, where the hornblende rocks are largely developed, traversed by veins of actinolite and tourmaline.

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, over 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 latter 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.

Between the Fortescue and the Ashburton Rivers, at the heads of the Robe and Cane Rivers, there is a Palæozoic and basaltic table-land, which in places is much broken, consisting of flat-topped hills which rise from alluvial plains.

The Gascoyne District.

This district extends along the coast from Point Cloates South to a point a little South of Sharks Bay and Eastward to the boundary of the Colony, embracing the most of the Ashburton River, the Lyndon, Minilya, Gascoyne, and its tributary the Lyons, the Wooramel, and Upper Murchison River.

The Ashburton River is about 500 miles in length, discharging its waters on the North-West 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 rock to its junction with the Henry, Duck Creek, and Hardy, where it spreads out into large alluvial plains, often 20 and 30 miles in width, with here and there low ridges of clay slate, and quartz, and 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, through rough slaty country, which closes it in some places for a few miles, causing it to flow in a deep channel, often almost a gorge, and then opening out again into large alluvial flats.

This belt of country along the river 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 a point 30 miles above its junction with the Ashburton, where the range closes in, it flows in a deep gorge between cliffs of crystalline limestone, from which many heavy springs break out. 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 slatey and granite country, taking their rise in the great table-land at the head of the Fortescue River.

Along the coast, between the mouth of the Gascoyne, around North-West Cape and Exmouth Gulf, and 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.

Between the Minilya, the Henry, 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, through which the rivers have cut large valleys and deep gorges in these almost horizontally bedded rocks.

The Minilya and Lyndon rivers take their rise in the limestone 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 rocks, and discharging themselves into a large swamp, which is separated from the sea by a low coastal sandstone ridge. 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.

The Gascoyne River, for the first 20 miles from the coast, flows over an alluvial or estuary deposit 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 through a gorge in the Kennedy Range, where Mesozoic rocks, consisting of sandstone and limestone, are met with. For 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, often very rich in fossils, but up to the present no sign of coal has been found. Just above this, the river takes a sudden bend to the North, opening out into fine alluvial and stony flats, with bold ranges of crystalline rocks rising abruptly 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, and fresh water can be obtained nearly anywhere at a few feet from the surface, in its sandy bed.

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

The plains, stretching away in both North and South from the upper courses of the Gascoyne, are for the most part of the desert sandstone formation, strewn in many places with fragments of crystalline rocks and quartz, which latter also occur as low isolated ridges.

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 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 in the sandstone table-land between the Teano Range, Mount Labouchere, and the great flat-topped range that forms the water-parting between the rivers which flow in a North-Westerly direction, and those which flow to the Westward. This table-land is about 1,500 feet above the sea, and is broken in many places by deep gullies, which the streams have cut down to the older rocks beneath, and in other places by the obtrusion of bold masses of crystalline rocks, which often rise to a considerable elevation above sea-level.

Sharks Bay forms one of the few striking features of the coast, which, as a rule, is singularly unindented or broken. It is a good harbour, but shallow, 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 Epireux 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 the coast down to the mouth of the Murchison, present low vertical cliff faces to the sea, composed of 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 Wooramel River is about 150 miles in length. It flows in a Westerly direction from a point near the Upper Murchison to Hamelin Pool, Sharks Bay. Very little is known of this river generally, as the country along its banks is poor, and it is off the main track to the North, but from a geological point of view it is one of the most interesting rivers in the Colony, as a better series of rocks are exposed in its cliff than 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.

The Victoria District.

This district extends along the coast from Sharks Bay South to Jurien Bay and Eastward to the South Australian boundary.

The Murchison discharges itself into the sea at Gantheaume Bay, 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, passing through a broken Mesozoic table-land (which is the Northern extension of the flat-topped hills about Northampton); whilst in the bed of the river, in places, the shales similar to those of the Irwin and Greenough are met with, but in which no fossils have yet been found by which their age can be determined.

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 or fossils, though springs break out in the same manner as on that river and on the Irwin. This is evidently due to the fact that many of these horizontally bedded Carboniferous rocks are impervious, which causes the water percolating through the sandstones from the higher country to the Eastward to come to the surface at their lower outcrop.

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, 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.

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 granitic rock rising abruptly from the plain, or low ridges capped by horizontally bedded ferruginous sandstone.

The Murchison rises in the edge of the broken table-land amongst the 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, and intersected by numerous quartz reefs. They are surrounded by large alluvial flats of red clayey loam and sand, which are broken in places by 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 become 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 the salt water which has accumulated in the large pools in the middle courses of the river down, spoiling all the fresh water pools in lower part which are filled locally 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.

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

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

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

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, a quantity of the sand is 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 aërated 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 very 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 extremely low, and when heavy rains fall in the interior they are subjected to floods, by which fences, houses, and stock are washed away. These flats are bounded on the North-West by the broken table-land, on the South by the low coastal limestone ridges, whilst they are separated from one another by a low sandy ridge.

The Greenough river is about 150 miles in length, and flows in a South-Westerly direction, discharging itself into the sea a little South of Champion Bay. Following up its course to the North-East, it leaves the flats and flows in a deep channel through high sandplain country, the underlying rocks of which, exposed in the cliffs beside the river bed, are white and coloured soft shaley sandstones and dark-coloured 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 Tallering Peak (which is the only hill in this district), and so on in a more easterly direction to Yuin, where some small gold-bearing reefs were found.

At this point the valley opens out into the fine alluvial flats of the Murchison District, with here and there low ridges of Metamorphic and Granitic 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 rock, with very rich auriferous reefs, is met with.

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 overflow into the rivers occasionally; but as this very rarely occurs, 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 misguiding to strangers; but many other physical features are the same. For instance, the *rivers* are flood-water channels, the *inlets* are rarely connected with the sea, 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 horizontally bedded ferruginous sandstones), with large alluvial flats around the salt clay-pans, and here and there low ridges of Metamorphic country, with occasionally, where these rocks are of a harder nature, 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 Irwin rises about 50 miles from the coast, in the crystalline range of hills of which Peterwangy is the highest. These hills are partially covered on their spurs by large deposits of red clay, clay ironstone and ferruginous sandstone, through which the river has made a deep channel exposing the Carboniferous series beneath, which here rest unconformably upon the old crystalline rocks. The Carboniferous series is here represented by beds of clay, claystone, micaceous clay, limestone, sandstone, and shale with gypsum, iron pyrites and coal seams, of considerable thickness, as there is a steady dip throughout to the North-East. Through these rocks the river has cut a gorge showing cliff sections 200 to 300 feet in height and on the top of which the ferruginous sandstones and conglomerates are seen to rest unconformably, and, where breaks or faults occur in the carboniferous rocks, they descend to within a few feet of the river. Lower down the river, where the clay beds make their appearance, the valley opens out into a large flat surrounded by broken flat-topped hills and undulatory country of Mesozoic age, the surface of which is covered by sand all the way down to the coast, where the coralline and sandy limestones make their appearance as coast hills.

A little to the South of the Irwin River, between Yandenooka and Arino Springs, are low ranges of crystalline rocks, in which rich patches of mineral country occur; these have not been worked at present, as the expense of cartage over the sand plains would consume all the profits.

The Coast line South of this to the Moore River consists for the most part of Tertiary and Recent deposits, chiefly marine, sand-drifts, shell gravels, and marls, with here and there salt lagoons and swamps separated from the sea by ridges of sandstone or limestone, which often reach 300 feet in height. Parallel to the shore are a series of flat-topped ranges, rising 600 feet above the sea, composed of horizontally bedded sandstone, ferruginous claystone and mottled limestone containing fossils of Mesozoic age. Further South, on the Moore River, are found sandstones, chalky limestones with flints, and ferruginous sandstones containing fossils of Cretaceous age with numerous stalactitic caves and underground water-courses.

Inland are undulating sand plains, rising 800 feet above the sea level, of coarse silicious sand, clayey sand, clay, limestone, and ferruginous sandstone, with here and there in the hollows heavy impermeable clay, which, collecting the water draining from the overlying sands and sandstones, forms swamps.

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

THE SOUTH-WESTERN DISTRICT.

The coast between the Moore River and the Leeuwin, including the Darling Range.

The general description of this tract of country is a low sandy plain from 10 to 20 miles wide, with many swamps and salt-water estuaries, bounded on the Eastern side by the bold cliff-like face of the Darling Range. This range runs North and South, following the coast, being highest near the Murray River and breaking up towards the South coast.

This coast line comprises a range of cliffs of coralline and shelly limestones, and calcareous sandstones, containing Recent shells, and, where the rivers have removed these beds, large drifting hills of marine sand occur. These formations are mostly overlaid by a white silicious false-bedded sand, often rising into ridges 50 to 100 feet high, and which inland attain an elevation of 300 feet. This sand in well sections proves to be a compact red sandstone, destitute of organic remains, sometimes attaining a thickness of 40 feet. Beneath this sandstone inland are found calcareous sandstones and gritty conglomerates, whilst oyster beds and other estuarine deposits are met with in the valleys.

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

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

Flanking the main range (on the Western face) are beds of clay slate, mica schist, and flaggy sandstones, with quartz reefs, which, near the Murray, dip 60° to 70° to the West and strike 10° East of North, while on the Canning the strike is North and South and the dip vertical. To the North these beds change into micaceous sandstones, containing quartz veins, numbers of which, together with diorite and porphyry dykes occur along this face of the range and are often associated with metallic ores, though none have been found that were large or rich enough to pay for working. The quartz reefs as a rule contain a large quantity of iron pyrites, which on assay has always proved to carry gold, but in no case rich enough to work.

This range, which presents a bold escarpment to the coastal plains, rising to an elevation of 1,800 feet above the sea, is principally composed of hard crystalline rocks, *e.g.*, granite, syenite, porphyry, and gneiss, containing numerous dykes of granite, diorite, and serpentine, quartz veins, and ironstone lodes, covered for the most part with cappings of red clay, ferruginous sandstones, grits, conglomerates, nodular clay, ironstone, sand, and kaolin, sometimes as much as 40 feet in thickness, and as high as 1,200 feet above sea level. These beds have been classed as Devonian, but there are no sufficient data to confirm this view, as they are only surface deposits, destitute of stratification and organic remains.

A marked feature on the South-West coast is the chain of tidal lakes, inlets, and swampy alluvial flats which follow the coast, sometimes connected with the sea, and at others separated by the sand-hills. The bars across the mouths of most of the rivers keep them fresh for a great part of the year—after the winter floods have expelled the salt water. There is plenty of evidence to prove that this coast is rising rapidly, in addition to the fact, that many old colonists remember when land at Fremantle, now quite above the water level, used daily to be covered by the tide.

Between Cape Naturaliste and Cape Leeuwin there is a line of ranges of crystalline rocks, flanked towards the sea by limestone cliffs, and running parallel to the Darling Range, at a distance of 30 miles to the Westward of them, the country between them consisting of sands, loams, clays, and gravels beneath which coals of fair quality have been found.

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

Columnar Basalt makes its appearance at Bunbury and further to the South at Cape Beaufort, as well as in several places between these points.

On the Eastern side of the Darling Range, on the Collie River, some large coal seams have been discovered; these outcrop in the bed of the river in some poor sandy and swampy country, of which there is a considerable extent, but what area of country is covered by the coal-bearing formation it is impossible to say until the boring operations are more advanced.

The Plantagenet District.

This district extends along the South coast from Point D'Entrecasteaux to Eucla.

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

About 50 miles to the Northward of Albany, stands the Stirling Range. It is about 50 miles long, runs East and West, and attains an elevation of about 3,500 feet above the sea level. The rocks of this range are not of so highly altered a character as is generally the case in this colony; they consist of quartzite, sandstone, ferruginous slaty sandstones, and slate, with quartz reefs (probably of silurian age), striking East and West with a variable dip. The country between this range and Albany is mostly granite, large masses of which rise through the sand, with which a good deal of it is covered.

Eastward the coast presents a series of bold granite and metamorphic rock headlands as far as Cape Arid, the granite being overlaid by fossiliferous Mesozoic rock which form the high sandy tableland of the interior, probably extending in patches as far North as Giles' Great Victoria Desert.

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

On the top of this is a great table-land which extends some 200 miles into the interior; it has no rivers, but the rainfall (flowing underground) soaks into the porous limestone, and is discharged at the base of the cliffs, which are very interesting from a geological point of view, being very largely composed of fossils.

The Eastern District.

On penetrating East into the ranges the character of the rocks change, the hard granitic rocks being replaced by crystalline schists, often of a comparatively soft nature, but still traversed by numerous quartz and iron veins, and diorite dykes.

Along this line of country many of the Rivers run North and South over large alluvial flats, which are the principal agricultural tracts of land.

The rivers in this district, for the most part, bear different names, as when discovered by the early explorers they were named differently from the coastal portions, owing to their flowing in a different direction.

At the North bend of the Avon, where it turns abruptly to the West, and cuts through the hard belt, the rocks are gneiss and mica schist, and contain quartz veins and several rich lodes of magnetic iron, which ore has been tested and proved to be very rich, and to yield iron of great purity.

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

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

About the interior itself very little is as yet known, but from the accounts of the explorers, it is very similar to this, but almost waterless, except in very exceptional seasons.

GEOLOGY.

The science of Geology naturally appears very complicated to persons who have spent all their lives in this Colony, or to those who have not studied the subject until they came here, as they have no opportunity of observing the sequence of the more modern rocks, which places them in a somewhat analagous position to a person starting to study the most complicated rules of arithmetic before mastering the simple ones. True we have a few of the most modern beds exposed along the coast, but formations of intermediate age between these and the Metamorphic rocks are rarely met with, as their outcrop, where they do exist are mostly covered by surface deposits, and even in the beds of the streams no good sections are to be obtained, so that when they are exposed in patches they are of no assistance to the student. It being perfectly impossible, therefore, for one to study the gradual changes from the most recent to the oldest rock, the science can only be taken up in a purely theoretical way, hence very erroneous ideas are as a rule conceived regarding the formation of the older rocks which contain veins and dykes. As this formation is the only one of any interest to the prospector and miner, and as this book has been written especially for them, we shall confine ourselves principally to the study of how these rocks and mineral veins were formed.

It is needless to go back to the time when the earth existed in the form of gas, but it will serve our purpose if we commence with the formation of the oldest sedimentary rocks of which we know anything. The first great principle to fix in one's mind and never lose sight of is that during all geological periods things have been going on much as they do to-day, with only the difference that the physical forces at work are gradually losing their intensity, and the earth is now settling down as a man does as he advances in years. In the early days of the earth's history, earthquakes were probably more violent and frequent than to-day; there was greater volcanic activity, and probably a much greater rainfall, with a correspondingly increased denuding action.

This difference may be accounted for by the fact that the earth's internal heat was far greater then than it is now, which would cause greater evaporation from the earth itself; but as it was probably slightly further from the sun than it is now, the upper atmosphere would be correspondingly cooler, which would cause a rapid condensation of the aqueous vapour as it rose, causing it to fall as rain or snow.

The solid crust of the earth was also much thinner, which would render it liable to be frequently broken by the earth strains, and up the fissures so caused molten matter would be forced, with thermal waters at enormous temperatures with mineral matter in solution. The shape of the land surface, too, would probably have been very different, the hills attaining much greater elevations, for after the first consolidation of the earth's crust it would have been broken and thrown up on end many times from the contraction of the inner mass as it cooled, until it eventually attained too great a thickness to be affected in such a marked degree.

Now, supposing we start at this period, when the oldest known sedimentary rocks were being formed at the bottom of the ocean (bedded rocks are formed in this manner). The heavy rains falling upon the hills would rush down their steep faces, breaking away the rocks, and carrying them down in the form of mud, sand, gravel, and boulders towards the sea, where they are sorted by gravitation, the coarser nearer the shore, and the finer, which would be held longer in suspension, further out; this latter would form mud beds in the deep water, whilst the sands, gravels, and boulders would be deposited near the shore.

In course of time bed upon bed would be built up in this manner, when, with pressure and heat, they would be altered, the mud into clay, shale, slate, schists, &c., and the sands, gravels, and boulders, by the passage of thermal waters, into sandstones, quartzites, and conglomerates.

But these beds have not remained in the horizontal position in which they were deposited, but were, whilst they were yet flexible, laterally compressed by the shrinking of the earth's crust, which folded and contorted them, more beds being deposited unconformably upon these, and the whole gradually compressed and consolidated.

In the course of time these old sea bottoms were gradually elevated, and became land surfaces, whilst other tracts which had been land gradually subsided, and were covered by the sea.

The more modern of the sedimentary rocks were deposited in a similar manner, but have been generally built up more slowly, and have not been altered or contorted so much.

When the old rocks, in time, became quite solid and would no longer adapt themselves to the contraction of the internal mass they had to break, and up the fissures thus formed quantities of molten rock were obtruded, often in such quantities and at such a high temperature as to melt the sedimentary rocks on either side for a considerable distance; but as these rocks were melted under great pressure, without any movement in the mass taking place on cooling, they still retained their bedded character, although changed into granitic or schistose rocks, whilst any limestone beds were changed into marble, and coal into graphite (plumbago).

During this cooling, or at a subsequent period, cracks and fissures were formed, into which thermal water found its way, depositing the mineral matter it held in solution on the sides of the fissure in layers, which would cause the banded appearance which is so commonly met with in veins, filling it by degrees in the same manner in which water heavily charged with lime gradually chokes up a pipe.

Veins are fissures or faults which have been infilled by mineral matter in solution, either from small cross fissures and leaders, or directly, when the strata is pervious, from the side of the vein itself, which has been mostly the case in this colony, where, as a rule, the reefs have one good wall coated with a greasy impervious casing, whilst on the other side the country is much broken, and many small veins and leaders or feeders strike away from it into the country, the rock on this side being as a rule more pervious.

In what state the metals were held in solution it is impossible to say, as we have no means of experimenting with them at the enormous temperature, and under the tremendous pressure that existed when they were deposited; but it is highly probable that they were in the form of double sulphides, whilst the silica was probably in the form of soluble sodic silicate.

Although mineral veins occur mostly amongst the older rocks, metal occurs in minute quantities throughout the whole geological series, and water in some places contains an appreciable quantity of them in solution. It was upon this fact that the theory of the lateral infilling of mineral veins was based, as previously their presence could only be accounted for by the theory that all lodes were filled from below, the vein stuff being thrown up in a molten state. But now that we know that they are all soluble under certain conditions, it is very probable that highly-heated water, charged with certain salts, would dissolve the metals from out of the rock through which it passed, depositing them in the fissures.

GEOLOGY OF THE COLONY.

Hitherto it has generally been imagined that the formations to be found in Western Australia were limited in number, and that the rocks mostly were either granite or sand; but that this was quite erroneous will be seen by examining the table of strata given below, which shows the various formations now known, and which will probably be much extended when all the country has been thoroughly examined.

Table of Geological Formations.

Sedimentary.

Cainozoic.	*Quaternary.*	*Recent (Holocene).*	Alluvium of lake basins and river valleys, river gravels, estuarine deposits, gypsum and salt beds, sand dunes, sand plains, raised beaches and shell marls and gravels, brick earth, mangrove swamps, ferruginous sandstones, nodular claystones, and clay, &c.
		Pleistocene.	Ancient river gravels and lake beds. Lower estuarine deposits, shelly limestones and sandstones of the coast.
	Tertiary.	*Pliocene.*	"Pindan" sands and gravels (often cemented by oxide of iron), gravel and ironstone. Ferruginous sandstones and variegated clays, with beds of lignite.
		Miocene.	Not known.
		Eocene.	Coralline and chalky limestones with flints, calcareous and ferruginous sandstones and grits.

Mesozoic or Secondary.	*Cretaceous.*	Chalky limestones with flints, sand, ferruginous sandstones, limestones, clays, micaceous clays, conglomerates, and coal seams.
	Jurassic.	*Oolites* :—Oolitic limestone, clay ironstone, ferruginous sandstone, grits and conglomerates. *Lias* :—Ferruginous and variegated limestones, clays and ironstones.
Palæozoic or Primary.	*Carboniferous.*	*Upper* :—Sandstones, grits, conglomerates, and shales, with small quartz veins, and nodules of ironstone. *Lower* :—Limestones variously coloured, mostly hard and often magnesian limestones, mudstones, fire clay, micaceous clays and shales, with iron pyrites, gypsum, and coal seams, calcite, agate, calcedony, and jasper veins, lead, zinc, and copper ores.
	Devonian.	Sandstones, coarse grits, conglomerates, shales, slates, and hard limestones, with veins of agate and calcedony, and micaceous iron.
	Silurian.	Clay-slate, limestones, marble, dolomite, sandstones, quartzites, and conglomerates, with veins of quartz, calcite and metallic ores and gold.
	Cambrian.	Crystalline limestones, sandstones, grits, quartzites clay-slate, and sandy flags, with numerous veins of quartz and calcite, gold, copper, lead, and iron ores.
Azoic.	*Archæan, Crystalline.*	Marble, quartzites, altered grits, mica slate, mica schist, chloritic schist, hornblend schist, talcose schist, garnet rock, gneiss, and granite, with numerous quartz reefs and mineral veins. This is the principal gold-bearing formation.
		Igneous.
	Volcanic.	Basalt, dolerite, volcanic breccia, and obsidian.
	Plutonic.	Diorite, feldstone, amygdaloids, syenite, granite, porphyry.

The Igneous rocks are of all ages, resulting from the solidification of molten matter which has been forced upwards from the interior of the earth, filling fissures it has formed, pre-existing faults, or has been ejected from vents at the surface.

They are usually divided into two classes, according to the circumstances under which they have become solid; those which have cooled down on or near the surface are called volcanic, and those that have solidified at some depth plutonic. They are often composed almost entirely of silica, and seldom contain less than 50 per cent. of that mineral.

Mineral Veins.

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

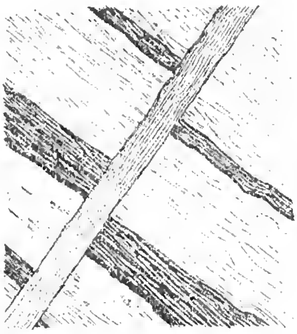
Mineral veins may be divided into the following classes:—

True Veins, sometimes called "Right" or "Fissure" lodes. This class of lode is best defined as a fissure of indefinite length and depth filled with a mineral substance, which if rich in a metallic ore would be called a lode, or rich in gold a reef. Veins of this class are supposed to have been caused by movements of the earth's crust, and therefore probably extend for a considerable depth. The walls of true veins are generally striated, showing that a movement has taken place.

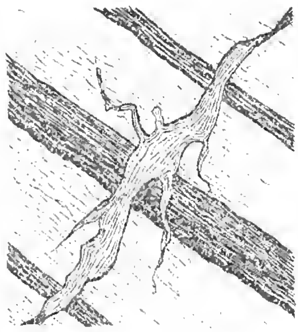
Gash Veins are not true fissures, as no dislocation has taken place in the earth's crust, but are simply cracks infilled with mineral matter, and although

MINERAL VEINS

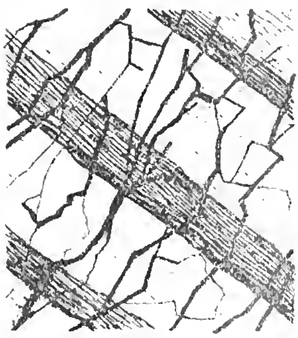
TRUE VEIN



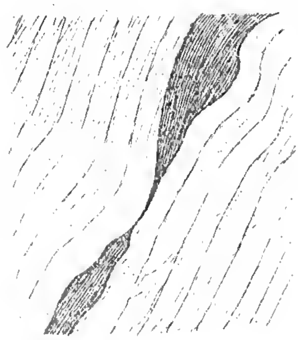
GASH VEIN



STOCKWORKS



SEGREGATED VEIN



sometimes of considerable size and richness they cannot be depended on to extend so far in depth or length as true veins. The walls of gash veins are not striated.

Segregation or Bedded Veins are cracks following the bedding of the rock, but like gash veins their walls are not striated, and they cannot be depended upon to continue in depth.

Stock Rocks are networks of small veins in a rock carrying ore, portions of which are rich enough to work but with no true lode formation.

Artesian Areas.

An Artesian Area, is an area over which artesian water may be obtained by sinking, whilst *artesian water*, is water which, when either tapped by a bore or shaft, rises and flows above the surface in the form of a spring, the supply being fairly constant. Everyone is, of course, familiar with the stereotyped encyclopædia definition: "Artesian wells derive their name from Artois, in France, where they were first largely used in Europe, although they were employed in the East from very early times;" and "An artesian area is a basin-shaped depression surrounded by high hills." The last of these is not only incorrect, but misleading, as any one ignorant of the subject would naturally think that an artesian water supply depended entirely upon the surface configuration of the area.

The subject of artesian areas is a very complicated one, and without a thorough geological knowledge, with a certain smattering of dynamics, it is impossible for anyone to give a reliable opinion on the subject, as the main points to be considered are—1st, the shape of the country; 2nd, the geological formation; 3rd, a cause why, if a bore were put down and water struck, that it should rise above the surface.

The conditions of an artesian area are as follows:—

1. The surface must be comparatively low, and there must be much higher land on some side or sides of it.
2. The geological formation must consist of one or more pervious beds, such as sand, sandstone, limestone, &c., between two impervious ones, such as clay, shale, &c.
3. The pervious bed must outcrop on the high land and dipping under the plain between the clay beds, whilst the point selected for the well must be considerably below this porous outcrop, which collects and stores the rain.
4. The supply will depend upon the rainfall and the surface catchment area of the outcrop of the pervious beds, whilst the pressure will depend upon the level at which the water stands in these beds above the surface where the bore is sunk. Springs are generally met with at the edges of artesian areas inland, but along the coast the water-bearing beds discharge themselves very often below the sea level.

As a rule, the main point, what an artesian well is, is lost sight of, its principal characteristic being that the water rises above the surface, and is therefore a flowing well, not being, as many suppose, simply a very deep tube well, from which the water has to be pumped. The definition should therefore be *a flowing well*, and the description of the area where space is limited should be left out, without it is said to be *an area in which artesian water may be obtained.* An artesian well being a flowing well, there must be some cause for this phenomenon; the basin-shaped area will not account for this, as there is no reason why this water should not break out as springs, filling the whole valley to the level at which the water is standing in the water-bearing beds.

An artesian area is mainly dependent on the geological formation of the country, which must consist of one or more pervious beds, overlaid by impervious beds, dipping under the plain, the pervious beds outcropping on the highest ground, as the rain falling upon this outcrop soaks away down to be imprisoned between the impervious beds, and stands at a certain elevation, according to the natural obstructions in the way of its passage towards the sea. Should this water level be above the level of the country where the impervious beds overlay the water-bearing stratum, then it is an artesian area, for if a shaft is sunk down to the water-bearing bed, the water will rise above the surface, or if confined in tubes it will rise to the same level in the tubes as the water is standing in these beds on the higher ground.

Another question on which there seems to be a good deal of confusion is one of dynamics; a column of water a certain height gives a certain pressure to the square inch; no matter the size of the column the pressure will be exactly the same, as it is only the vertical pressure of the water which is perceptible. For example, the pressure on the pipes in Perth is only equal to a column of water standing at the same level as the water in the reservoir. This question of pressure is generally confounded with supply; for instance, a pipe 20 feet high filled with water gives a certain pressure; now replace the top four feet with a tank filled to the top, the pressure remains the same, but it will take much longer to run all the water off. Multiply these columns and tanks to any extent, connecting them all at a common junction, then take the pressure, when, if the surface of the water still stands at 20 feet above the point where the testing is done, the pressure will be exactly the same as the one single pipe of water of the same vertical height.

A basin when spoken of in the artesian sense refers more to the geological formation than to the surface, for an artesian supply may be obtained on the top of a hill, provided the water-bearing beds outcrop at a still greater elevation.

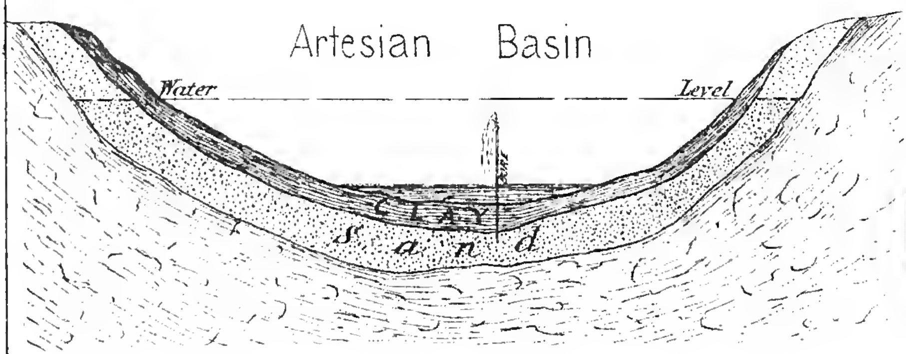
The question of artesian areas is therefore most complicated to one who has never studied the subject, for although basins are always talked about, no such things are found at the surface and rarely in the rocks themselves, which are generally folded into a synclinal trough, into the centre of which the water is thrown, and along which it gradually percolates towards the sea.

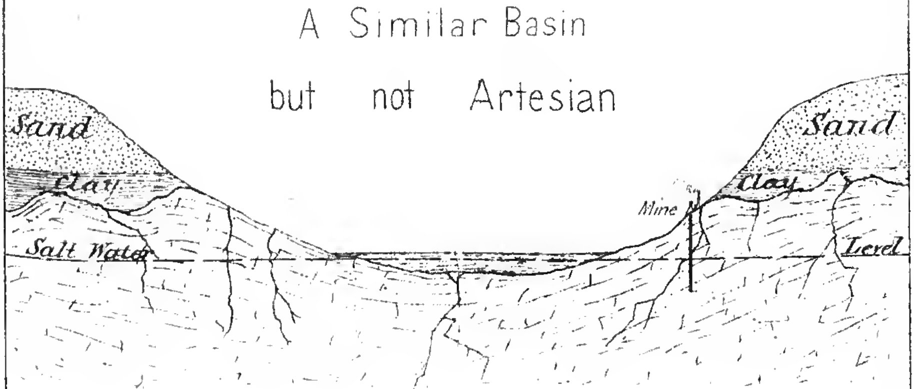
Some years ago the idea was started of obtaining artesian water on the Yilgarn Goldfield on the grounds that it was a basin-shaped depression, with high ground all round. The arguments used in support of the idea were of the class that artesian water existed in the interior of the other colonies near the salt lakes. Some people went even so far as to state that water would be struck at 1,000 feet, as the pressure of the rocks would cause the water to rise, forgetting that a corresponding pressure would be required to force the water down.

Let us consider the Yilgarn District.—We know that wherever mineral veins exist the country must be more or less broken; in fact, lodes are fissures, either running with or across the country; whilst the bedding of the rocks in this district is, as a rule, inclined at a very high angle, sometimes dipping even vertically. The pervious beds, therefore, as well as the impervious ones, outcrop, and if water existed in them under pressure it would have to overcome no obstacles in its way to rising either in the beds themselves or up the fissures, and so making its escape at the surface.

The mistake into which many well informed persons have fallen in this district is that, 1stly, it is basin-shaped; 2ndly, pervious beds outcrop on the highland (sandplains); 3rdly, impervious beds are met with at the surface on the low ground (lake beds); therefore, if bores were put down through these, artesian water would be obtained. Unfortunately for this argument, the sandplains are only cappings and do not underlie the clays of the lakes, which rest directly upon the upturned edges of the old rocks, and when sunk through prove that they overlay a large water supply, but which unfortunately is extremely salt, and is not under any pressure, so that no artesian water exists.

ARTESIAN AREAS





Artesian water is, as rule, met with in the Mesozoic or Tertiary formations, which rocks are more or less horizontally bedded and are little faulted or broken, but it has never yet been met with in highly Metamorphic or mineral country, and did such a supply chance to exist it would be most unpleasant for the miners, for, without they had extremely powerful pumping machinery, they would be flooded out if there were any supply at all, for if enough water will pass up a small pipe to supply a whole town how much water would a mine make?

Artesian areas probably exist in many places in the interior, but never where there are outcrops of mineral country or granite rocks. Areas probably exist between Geraldton and the South coast and many places further North, also in Carboniferous rocks at Wyndham, Derby, and on the Gascoyne, the Murchison, the Irwin, and the Collie Rivers.

CAINOZOIC.

Recent.

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

On the North Coast there are some extensive alluvial deposits, not generally in the river valleys themselves, but mostly following the sea coast, or in other places what was once the bed of the river; they are not, as a rule, of any great thickness, as outcrops of rocks are frequent.

River Valleys.—This loamy deposit is formed by the rivers wearing away the old rocks, carrying the finer material down from the hills and depositing it on the open level country, forming large rich plains. These are often of great extent, and running back from the rivers for a considerable distance, and are often very similar in character to those of the lake basins, but with this great difference, they rarely contain salt. They are best studied on the Upper Murchison, the Gascoyne, or Fitzroy Rivers, where there are large clay and loam floats, often many miles wide. They have probably been formed in the same manner as the lakes, but having been better drained the salt has been carried away by the rivers. Certain tracts, however, still contain much salt, which gets replenished from time to time by large discharges of salt flood water from the lakes at the sources of the rivers.

All the rivers North of the Greenough form these large flats, but in the South the rivers do not; forming, instead, small ones of clay, loam, sand, and gravel throughout their courses, which are very fertile.

River Gravels.—These consist of sand, gravel, and fragments of rock, and are found in the beds of the streams, nearer their heads, as a rule, than the loams; also in the beds of all the large rivers, which are often as much as a mile wide.

Estuarine Deposits.—These deposits are met with at the mouths of the large Northern rivers, where there are periodical tropical and semi-tropical floods. The rivers bring down large quantities of mud, which they deposit near their mouths, forming (excepting where coastal currents interfere) a kind of swampy delta, for the most part salt and overgrown with mangroves, composed of a black greasy mud, full in many places of recent petrifactions of crayfish, wood, and worm tubes.

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

Salt and Gypsum Deposits.—These belong to the Lake Basins: it is, however, worth noting that gypsum occurs in the form of beautiful crystals *(selenite)* on some of the claypans in the interior.

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

Sand Plains.—The sand plains follow the coast in the Southern portion of the Colony, extend up to the ranges, and cover most of the lower ground. The sand here is much looser than in the interior, and is often of considerable thickness, being of a red colour and showing a false bedding, which proves that its origin is Eolian.

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

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

Pleistocene.

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

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

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

Shelly Limestones and Sandstones.—These occur all along the South-Western coast, and contain fossils very similar to the living forms; in many cases even preserve the nacre of the shells.

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

Pliocene.

"*Pindan*"—Cracked Plains.—These large sandy plains are largely developed on either side of the Fitzroy River, stretching far away to the Southward, where they form Warburton's Great Sandy Desert. Also on the Ord River there are some small stretches of this country, but nowhere of any very great extent. Owing to its porous nature these plains are waterless in spite of the heavy rainfall, but as a rule they are covered with abundance of vegetation.

Sand Plains.—These are the characteristic features of Western Australia, extending from one end of the Colony to the other. The great sand plains of the interior are often twenty or thirty miles across, but containing in places a good deal of clay and iron which cement the grains of sand together, and there being a fair rainfall they are covered with hardy vegetation, which during the two spring months are perfectly gorgeous with flowers, and form good summer grazing ground. They result mostly from the disintegration of the desert sandstone, which forms the table-land of the interior of Australia.

Ferruginous Sandstones and Variegated Clays.—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. They are probably of Upper Tertiary age, although they may be still more recent.

Gravel and Ironstone.—The deposits which are in reality indurated nodular ferruginous claystones called gravel, and either this latter cemented together or ferruginous sandstone called ironstone. They occur throughout all the Southern portion of the Colony, capping the spurs in the forest country up to elevations as great as 1,200 feet. They are sometimes, but rarely, of great thickness, but are more generally underlaid by pale yellow or white clays. They apparently owe their origin to the fires which, passing over the surface, would burn the clay into pieces similar in shape to burnt ballast, and this would naturally get weathered into a more or less rounded form.

Eocene.

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

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

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

MESOZOIC.

Cretaceous.

These beds consist of chalky limestones with flints, sandstones, and ferruginous sandstones, conglomerates and clays, and are well developed in the flat-topped coast range from Gingin to the Northward, and in places contain many fossils. The sandstones, ferruginous claystones, and grits of this series extend to the Eastward, capping the ranges and large table-lands of the interior. This formation is probably the Western extension of the great desert sandstone formation of the Eastern Colonies, where very similar rocks form the uppermost beds of the great artesian area. These rocks are apparently destitute of organic remains, but as they rest conformably upon the Cretaceous rocks both here and in South Australia they have been classed with them; it is, however, possible that they are of a more recent origin, having possibly been formed shortly after the elevation of this Continent, when, as the surface must have been almost a dead level, little if any denudation would have occurred, though the upper beds would have been altered and the organic remains destroyed *in situ* by the vegetation aided by the action of the weather. That in places these beds are of terrestrial origin there is not the slightest doubt, as in the quartzite beds, that cap them in some parts of South Australia, vegetable remains have been found, and in other places all the indications point to a swampy or lacustrine source.

Jurassic.

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

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.

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.

Carboniferous.

Upper.—Sandstones and shales of this age are mostly seen forming flat-topped hills, attain their greatest development along the North Coast, but they are also met with in small patches, as from the Dixon Range to Mt. Deception, on the Ord River; the Hardman Range, on the Nicholson River; the Haughton Range, to the South-West of Mt. Dockrell; the St. George's, Grant, and several other small ranges on the Fitzroy River; also on the Lennard River.

Coal seams of this age are also met with in the bed of the Collie River, about 30 miles East of Bunbury in the South-West, but their extent is at present unknown, as the whole surface is covered by more modern deposits.

Lower.—This formation outcrops first on the Irwin River, about 50 miles from the coast, which it follows, running North in a belt about 20 miles wide, being exposed in the beds of the Greenough, Murchison, and Wooramel rivers, where the superincumbent formations have been removed. On the Gascoyne River and to the Northward, they rise and widen out, forming a broken table, which crosses the Henry, Ashburton, and Fortescue, then turning away to the North-East, and disappearing beneath Warburton's Great Sandy Desert, but again making their appearance on the South side of the Kimberley goldfield, between Mt. Elder and the Antrim Plateau, outcropping all along the edge of the basalt flow.

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 they do dip slightly in one direction, they are invariably found in a short distance to dip in the opposite, whilst the streams have not cut sufficiently deeply into them to expose much below the magnesian limestone.

Devonian.

This formation is largely developed in the Carr-Boyd Ranges, also in a wide belt, which runs South from Saw Range to the Lubbock Range, a distance of about 200 miles. The narrow, abrupt Albert Edward Range, which is about 100 miles long, is formed by the outcrop of rocks of this age. The Barrier Range, to the Southward of the Leopold Range, appears now, from the determination of the fossils, to be also of this age.

Silurian.

To this period have been ascribed those clay-slates, limestones, sandstones, quartzites, and conglomerates, which are not highly metamorphosed. They occur in many places throughout the Colony, forming large ranges.

The Stirling Range, to the North of Albany, is probably of this age, and this formation is also to be met with in the Kimberley district, but up to the present no fossils have been identified.

Cambrian.

In this group are classed all the older series of rocks that have not been too highly altered to preclude the possibility of organic remains being discovered in them. Two fossils have been determined as belonging to this age, in the Kimberley district, where these rocks extend in a North-East and South-West direction from the Burt Range to the Southward of Mt. Dockrell, and it is in this belt that the principal gold discoveries have been made. In places the rocks are highly altered, but this is mostly from purely local causes.

The clay-slate auriferous belt of the Colony may also be of this age, but this cannot, at present, be determined.

AZOIC.

Archæan and Crystalline.

Crystalline.—These rocks are met with in a belt which runs from the South coast to the Upper Murchison River, at a distance of from 10 to 50 miles from the west coast. They also occur in the Northampton, Roebourne, and Kimberley districts. With these rocks are associated mineral lodes containing copper, lead, zinc, tin, and auriferous pyrites.

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

IGNEOUS.

Volcanic.

At Bunbury and Cape Beaufort columnar basalt occurs, and though only exposed at the coast, it probably extends inland under the modern Tertiary beds.

On the North-West coast there are several trap dykes, whilst South of the Nullagine, and on the Fortescue River, there are several lava flows, as well as dykes. The largest development, however, is met with in the Kimberley district, where an extension flow stretches from the head and East side of the Ord River into the Northern Territory of South Australia. Obsidian bombs are found all over the interior, but where they come from no one knows.

Plutonic.

These rocks occur throughout the Colony amongst the crystalline rocks, which they have displaced and metamorphosed. The granites are seen most abundantly in a belt of country about 50 to 100 miles wide, running North and South about 150 to 200 miles inland, where, rising out of the alluvial plains, they form bold red isolated hills.

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

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

MINERALOGY.

With a Description of the Minerals of Commercial Value which have been or are likely to be found in this Colony.

A Mineral is a substance obtained from the earth's crust by digging or mining. It may have been originally of organic origin, which has undergone certain changes called mineralisation, principally caused by heat, mineral water, and pressure. Coal is a mineral of this class, but the larger number of minerals are not of organic origin.

Mineralogy is the study of the physical properties of minerals, such as their chemical composition, crystalline form, hardness, specific gravity, colour, etc.

As in the study of mineralogy a knowledge of chemistry is necessary, a list of the elements, with their symbols and combining weights, is given here.

List of the Elements, with their symbols and atomic weights:—

Aluminum	Al.	27·0
Antimony (Stibium)	Sb.	122·0
Arsenic	As.	74·9
Barium	Ba.	136·8
Beryllium	Be.	9·0
Bismuth	Bi.	210·0
Boron	B.	11·0
Bromine	Br.	79·8
Cadmium	Cd.	111·7
Cæsium	Cs.	133·0
Calcium	Ca.	39·9
Carbon	C.	12·0

Cerium	Ce.	141·2
Chlorine	Cl.	35·4
Chromium	Cr.	52·5
Cobalt	Co.	58·6
Copper (Cuprum)	Cu.	63·1
Decipium	Dp.	?
Didymium	D.	147·4
Erbium	E.	168·9
Fluorine	F.	19·0
Gallium	Ga.	69·8
Glucinum	Gl.	13·5
Gold (Aurum)	Au.	196·2
Holmium	Hm.	?
Hydrogen	H.	1
Indium	In.	113·4
Iodine	I.	126·5
Iridium	Ir.	196·5
Iron (Ferrum)	Fe.	55·9
Lanthanum	La.	139·3
Lead (Plumbum)	Pb.	206·5
Lithium	Li.	7·0
Magnesium	Mg.	23·9
Manganese	Mn.	54·8
Mercury (Hydrargyrum) ...	Hg.	199·8
Molybdenum	Mo.	95·9
Mosandrium	Ms.	?
Nickel	Ni.	58·6
Niobium	Nb.	93·7
Nitrogen	N.	14·0
Norwegium	Ng.	?
Osmium	Os.	198·0
Oxygen	O.	15·96
Palladium	Pd.	106·2
Phosphorus	P.	31·0
Platinum	Pt.	196·4
Potassium (Kalium)	K.	39·0
Rhodium	Rh.	104·4
Rubidium	Rb.	85·2
Ruthenium	Ru.	103·5
Samarium	Sa.	?
Scandium	Sc.	44·0
Selenium	Se.	78·9
Silver (Argentum)	Ag.	107·7
Silicon	Si.	28·0
Sodium (Natrium)	Na.	23·0
Strontium	Sr.	87·3
Sulphur	S.	32·0
Tantalum	Ta.	182·0
Tellurium	Te.	128·0
Terbium	Tb.	?
Thallium	Tl.	203·3
Thorium	Th.	231·4
Thulium	Tm.	?
Tin (Stannum)	Sn.	117·8
Titanium	Ti.	48·0
Tungsten (Wolfram)... ...	W.	183·6

Uranium	U.	240·0
Vanadium	V.	51·0
Ytterbrium	Yt.	163·0
Yttrium	Y.	93·0
Zinc	Zn.	64·9
Zinconium	Zr.	90·4

This is a list of all the known elements, with their symbols and atomic or combining weights. The symbols are mostly abbreviations taken directly from the names of the substances themselves, but to this rule there are a few exceptions, principally where the name of the element is strictly English, when an abbreviation of the Latin name is taken, as this table of symbols is used by all nations.

The atomic weights are the relative weights the different elements bear to hydrogen, and from them the weight of any element in a certain substance can be determined, when the chemical formula of which is known.

For instance we know that common salt consists of chlorine and sodium, the chemical formula of which is Na Cl., as they combine atom with atom. Now if we look up chlorine we find its atomic weight is 35·4, and sodium 23·0, then we know that in each pound, ounce, or whatever weight is taken, 35·4 parts will be chlorine, and 23·0 will be sodium.

Hardness.

The comparative hardness of minerals is easily ascertained, and, being a most important character, should be first tested. It is only necessary to test a few minerals of known hardness with a knife, and upon one another, to be able to carry a very fair idea of the scales of hardness in one's mind, so that when far away in the bush, without proper means of testing the hardness of a mineral, it may be approximately determined. As a standard of hardness the following minerals have been selected, ranging from 1, the softest, to 10, the hardest known substance:—

1. Talc (soapstone), easily scratched by the finger nail.
2. Gypsum, not easily scratched by the finger nail.
3. Calcite, both scratches, and can be scratched by a copper coin.
4. Fluorite, will scratch a copper coin, but will not scratch glass.
5. Apatite, will just scratch glass, and is easily scratched by a knife.
6. Feldspar, scratches glass, but can only just be scratched by a knife.
7. Quartz, scratches glass easily, cannot be scratched by a knife.
8. Topaz, will scratch quartz.
9. Sapphire, will scratch topaz.
10. Diamond, will scratch sapphire.

The minerals which are harder than quartz are rare, but should any of them be met with, it will be best to send them to an expert to test and value.

Specific Gravity.

To obtain the specific gravity of substances, they must be compared to some substance taken as a standard; this standard is distilled water at a temperature of 60° F., and the process is as follows:—The substance is first weighed on a balance; next it is suspended from one of the scales of the balance in a glass of water, the other pan with the weight in it being kept clear of the water; now subtract the second weight from the first and divide the first by the difference obtained.

Let us say, for instance, that the substance weighed 6 ozs., but when weighed in water only weighed 2oz., we should subtract the 2 from the 6, which leaves 4, then divide the 6 by 4, which would give 1½, which put down in decimals would read 1·5 sp. gravity.

This at first sounds complicated, but is in reality very simple. The specific gravity of a substance is its relative weight to an equal body of water, or how many times heavier it is than an equal volume of water. The bulk of the sample being unknown, it cannot be compared with an equal bulk of water; therefore this has to be determined by displacement, the difference in weight between the sample weighed in air and water being the weight of an equal volume of water, or the amount of water displaced by the specimen. Therefore we divide the weight of the specimen by the weight of the water displaced, which gives its relative weight to an equal volume of water, the weight of the water displaced being obtained by subtracting the weight of the substance weighed in water from its weight in air. The specific gravity enables us simply to calculate the weight of a cubic foot of a substance, as we know that a cubic foot of water weighs 1,000 ounces; therefore, if we multiply 1,000 by the specific gravity of any substance, we have the weight of one cubic foot of it: thus the specific gravity of quartz is 2·6 x 1,000=2,600, a cubic foot of pure quartz, therefore, weighs 2,600ozs. Specific gravity is taken advantage of in separating substances from one another, as in gold workings.

Of course it is quite impossible to test the specific gravity of a mineral in the bush, but a very good idea can be formed of it, as everyone must have noticed the difference in weight to the bulk of different substances (termed heaviness); this is really its specific gravity.

Tenacity

Is one of the most useful physical properties of metals; it implies the power a substance has of holding together. Thus iron, in the form of steel, is the most tenacious metal, as a wire of that metal will stand a greater strain than a wire of equal size of any other metal; but in mineralogy it is used on broader lines, and may be said to include the following properties:—

1st. Brittle.—When a mineral breaks easily, or when it powders up on attempting to cut it.

2nd. Malleable.—When it can be beaten out into plates with a hammer.

3rd. Sectile.—When a slice may be cut off with a knife, like cutting a slice off wax, not splitting like mica.

4th. Flexible.—When a mineral will bend, and remain bent.

5th. Elastic.—When a mineral will bend, but will spring back to its original position as soon as the bending pressure is released.

Colour.

The colour of a mineral may be under two heads: first, the general colour as seen in a mass; next, the streak, which is the colour of the mineral when observed in a finely divided state, and is most generally observed by making a mark with the substance to be tested on a piece of unglazed porcelain.

Diaphaneity.

This is the property possessed by substances of transmitting light, or, in other words, its transparency. The degree to which minerals possess this property may be divided under five heads:—

1. Transparent: When a mineral offers no obstruction to the passage of light, and objects can be seen distinctly through it.
2. Subtransparent: When light can pass freely through, but objects are indistinctly seen through it.
3. Translucent: When light can pass through it, but objects cannot be seen through it.
4. Subtranslucent: When light alone is transmitted faintly at the edges.
5. Opaque: When no light is transmitted.

Lustre.

This property depends upon the nature of the surface of a substance, which causes more or less light to be reflected. The degree in which minerals possess it are classed under six heads :—

1. Metallic : When a substance has the appearance of a metal.
2. Vitreous : When a substance has the appearance of broken glass.
3. Resinous : When it looks like resin.
4. Pearly : When it looks like pearl.
5. Silky : When it looks like silk.
6. Adamantine : When it looks like a diamond. Brilliant or shining.

Electricity and Magnetism.

Many minerals become electric on being rubbed, when they will attract cotton or any other light substance, whilst one of the iron ores, called lodestone, is naturally magnetic, and several of the others which contain iron are attracted by the magnet.

Taste and Odour.

These properties are also possessed by many minerals, and by them they may be easily distinguished.

Cleavage and Fracture.

Cleavage.—When a mineral breaks up into definite forms, with smooth regular faces, such faces are said to be the cleavage planes.

Fracture.—When a mineral breaks up irregularly under a blow, the appearance of the fresh face is called its fracture. Thus the fracture is said to be even when it forms a plane of some extent, uneven when the surface is rough, conchoidal when the fractured pieces are concave on one side and convex on the other, splintery when the surface presents the appearance of a number of thin-edged scales, hackly when covered with numerous sharp points or inequalities.

Crystallography.—One of the most important branches of mineralogy is crystallography, which has of late years developed almost into a separate science, but here it is of little practical value in the determination of minerals, as they are rarely found in the form of crystals.

It may be described as a study of the crystalline forms and structure of minerals for the convenience of distinguishing species, each mineral being constant in its structure and crystalline form.

The chemical composition always bears a certain relationship to the crystalline form.

The form is almost entirely dependent upon crystallisation, as well as all optical characters.

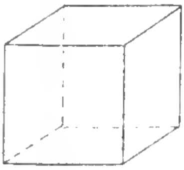
For this study a knowledge of mathematics is necessary.

The forms of crystals are very variable, but they may be divided into six systems :—

1. Isometric or regular system (called cubic, octahedral, &c.).—In this system three axes of equal lengths pass from side to side through a point in the centre, cutting each other at right angles.
2. Dimetric or square prismatic system.—These have three axes at right angles to one another, but only two of equal length.
3. Trimetric or right prismatic system, in which the three axes are of unequal length, but cut one another at right angles.

CRYSTALS

1



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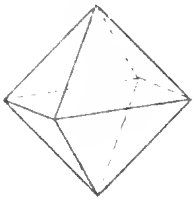

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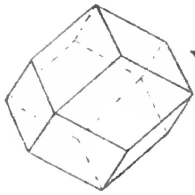

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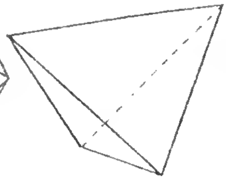

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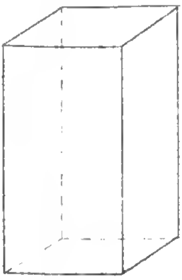

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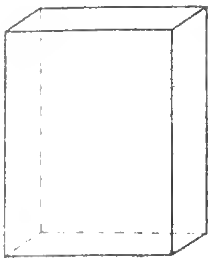

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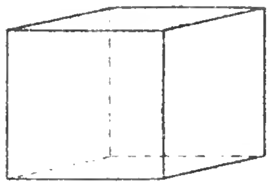

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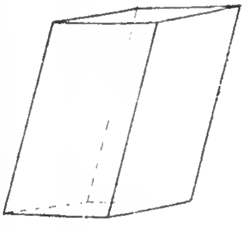

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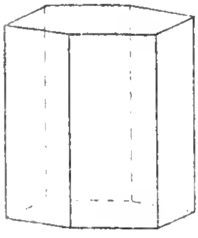

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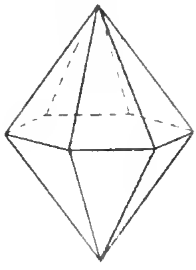


4. Monoclinic or oblique prismatic system.—The axes may be all equal or not, but two of them must be at right angles and one intersecting them obliquely.
5. Triclinic or double oblique prismatic system.—In this system the crystals have three unequal axes, which also intersect one another obliquely.
6. Hexagonal or rhombohedral system.—The crystals belonging to this system have four axes, three of which are on the same plane and inclined to one another at an angle of 60°, whilst the other axis cuts them at right angles in the centre. They are readily distinguished from the foregoing, as the number of faces surface planes of a kind around the vertical axis are always a multiple of three.

Crystallography is a very complicated subject, and as minerals in the form of crystals are rarely met with by prospectors, it is not worth while entering into it more fully.

The crystalline form in which minerals are found cannot always be depended upon, for although a certain mineral always crystallises in the same form, there are also casts, called pseudomorphs. The most common of these are the so-called "Devil's Dice," which are little cubes of red oxide of iron, being pseudomorphs or casts of crystals of iron pyrites, which latter mineral has been decomposed, the sulphur being given off when the iron combined with oxygen, and took the form of the cavity.

METALLIC MINERALS.

THEIR OCCURRENCE AND USE.

Gold.

Symbol, Au (Aurum); atomic weight, 196·2.

Gold is always found in the native or metallic state, but generally alloyed with silver, copper, or iron, and, although one of the most widely distributed and earliest worked metals, it is comparatively rare, owing to the fact that it mostly occurs in small particles disseminated through rock or gravel, which renders it difficult to extract. It has been always highly prized owing to its beautiful colour, the ease with which it can be worked, the fact that it does not tarnish when exposed to the action of air or water, which, added to its rarity, has caused it to be almost universally adopted as the standard of exchange.

In the early part of the 4th century, many Alchemists spent their lives in seeking what was called the Philosopher's stone, which was supposed to endow the possessor with the power of combining the baser metals in certain proportions, and thus transforming them into gold.

It has now been generally decided by chemists that gold is an element, or in other words that it cannot be split up into any more elementary substances, neither can it be manufactured from them. In the pure state its specific gravity is very high, being 19·3 times as heavy as an equal bulk of water, which physical character is taken advantage of in separating it from other minerals, for, except platinum and two or three of the very rare metals, it is heavier than any other substance. This metal melts at about 2000° Fahrenheit, and can also be volatilised at very high temperatures. In the pure state its colour and streak (a mark made by it on porcelain) is a deep golden yellow, but in the finely divided state it is either red or black, whilst by transmitted light it is green.

Gold is the most malleable and ductile metal, as a grain of it can be beaten out large enough to cover $54\frac{3}{4}$ square inches of 1-280,000th of an inch in thickness, whilst Faraday calculated that the gold from four sovereigns could be drawn into wire, would be long enough to reach round the earth at the equator. It does not readily enter into chemical combinations with the other elements, and when it does the resulting salts are very unstable, being decomposed when brought in contact with other metals, metallic salts, organic substances, or by exposure to the action of light and air. It is not acted upon by any simple acid, but is dissolved by chlorine in solution, or by nitro-hydrochloric acid forming auric chloride, one of its most stable salts.

Pure gold is so soft that it can be scratched by the finger nail; therefore it has to be alloyed with other metals to increase its hardness, silver or copper being the most generally employed. An alloy, it must be understood, is not always a chemical compound, but simply a mixture of two or more metals in any proportions, the English gold standard being an alloy of 11 parts of gold to one part of copper, but as this is not hard enough for jewellery the proportion of copper is greatly increased. The fineness of these alloys is spoken of as so many carat gold. Pure gold is expressed as 24, whilst in lower standards the number of parts of pure gold in the 24 is mentioned: a sovereign is 22 carat, or 22 parts gold and 2 copper.

As gold used in jewellery is mostly of certain standards as 22, 18, 15, or 12 carats, it is not necessary to melt it up to tell its fineness, but this can be done by marking with it on a black basaltic stone (called a touchstone), then treating the mark with dilute nitric acid and comparing it with golds of known standards similarly treated.

Gold also has the property of forming an amalgam with mercury at ordinary temperatures, when it forms a soft mass, in which the gold and mercury are found to be perfectly mixed. This affinity of mercury for gold is taken advantage of in its extraction.

For testing the presence of gold in very minute quantities the mineral is finely pulverised and agitated with an alcoholic tincture of iodine; into this solution a piece of filter paper is dipped and then burnt, when if the colour of the ash is purple it indicates the presence of gold; but this should be confirmed by evaporating the alcoholic tincture to dryness and treating the residue with nitro-hydrochloric acid, and again evaporating, dissolving the residue in water, and dropping in a drop of a mixture of stannous and ferric chloride, when a deep purple colour will be seen (Purple of Cassius), which confirms the presence of gold. Gold may be distinguished from iron pyrites, copper pyrites, and mica, by the ease with which it will cut with a knife. Iron pyrites, being as hard as quartz, will not cut; copper pyrites will cut, but it yields a greenish powder; whilst mica splits off in shining scales.

Another method, where the specks are too small to try them with a knife, and acids are not at hand, is to make the stone red-hot, and either let it cool or drop it into cold water, when the iron pyrites will turn red, the copper black, and the mica lose its lustre, whilst the gold will remain unaltered. There need be no fear of melting the gold, as it requires a much higher temperature than that of an ordinary fire.

Gold, besides being valuable as a medium of exchange, is one of the most useful metals. For jewellery it cannot be surpassed, owing to its beautiful colour, the fact that it does not rust, and the ease with which it can be worked. It is also used largely for plating and gilding, in both of which processes it was originally used in the form of leaf; but now it is found much more economical, when the article to be plated is metal, to deposit a thin coating of gold from solution upon it by means of an electric current, by which a very thin film of gold can be evenly deposited over a large surface. Gold is used also for colouring glass, the beautiful reds called ruby glass being due to the presence of it in small quantities. In photography it is also of great value, owing to the permanency of the beautiful tones that can be obtained by replacing the silver in the original print with it, and a great variety of shades are produced, varying from black, blue, pink to brown.

ITS OCCURRENCE.

Gold, as was before said, is always found in nature in the metallic state, but mostly alloyed with small quantities of other metals. It was formerly supposed to be always associated with quartz, which was considered to be an indication of it, but this idea has exploded, as it has now been found with calcite, serpentine, diorite, and granite, and associated with the ores of lead, iron, antimony, copper, and tin. It is true, certainly, that quartz commonly occurs with it, but the white quartz reefs which were first worked have not, as a rule, proved as rich as the more mineralised veins. Athough always found in the metallic state, it is highly probable that it also exists in nature as a sulphide, but as this salt is so unstable, it would be decomposed before this could be determined. Gold occurs in nature in two forms, namely alluvial gold and reef gold. In the former state it is found in the stream beds, where it has been derived directly from the reefs by the eroding action of the stream, the gold being left behind at the bottom of the gully, owing to its great specific gravity, whilst the lighter minerals have been washed away.

Gold in the alluvial form is generally of a higher value than reef gold. This may be accounted for by the oxidization of the baser metals with which it is alloyed, as in the finely divided state this separation is easily effected. Even if a coin like a sovereign is taken and heated to redness, the surface will be tarnished either a reddish or blackish colour, owing to the thin coating of oxide of copper, and when this is removed the gold on the surface of the coin will be found to be chemically purer.

Another strange thing about alluvial gold is that it is found in much larger masses in the alluvium than it has ever been found in a reef, often occurring as nuggets of many pounds weight, whilst in the reef from which it was derived it is only met with in a finely divided state. This has given rise to the miner's theory that gold grows, and can be accounted for by the fact that pockets or ledges become filled with fine gold, when by some very slow process, the action of which we do not yet know, the whole becomes one solid mass. That such an action takes place we know, for we always find alluvial gold taking its shape from the bottoms or holes in which it has been accumulated, often appearing as if it had been poured into the crevices in a molten state. This joining together of the small particles of gold is probably due to the small amount of gold in solution, which is deposited on the surface of the grains until it eventually joins them together.

Reef gold occurs in veins, lodes, or dykes, the term reef or vein being used to describe a lode where there is a predominance of an earthy mineral, lode where an ore or metallic mineral is in the larger proportion, and a dyke when it owes its origin to plutonic action, the matrix being an igneous rock. These reefs and veins mostly occur in the older Palæozoic formation, the rocks being generally clay, slate, sandstone, schist, &c.

AURIFEROUS BELTS OF THIS COLONY.

There are five auriferous belts in this colony, the first of which runs nearly North and South, about 200 to 250 miles from the coast, in the Southern portion of the colony, and it is on this belt that Yilgarn and the Murchison goldfields are situated. The Coolgardie belt, about 100 miles to the Eastward and parallel to the Yilgarn belt, extending from the Dundas Hills through Coolgardie, Ularring, to the Eastward of the Murchison. On the Ashburton the belt runs North-West and South-East, but is probably the extension of the Yilgarn belt, which ends at the head of this river. The Roebourne belt strikes East and West along the North-West coast from the Nicol River to the DeGrey River, disappearing beneath the sandy table-land to the Eastward. The Kimberley belt strikes in a North-East and South-West direction, and is very probably the extension of the Roebourne belt, re-appearing on the North-Easterly side of the sandy table-land. These belts carry gold for a great length; the reefs, as a rule, are of great size, very rich, and wherever they have been tested they have proved to be good. A large quantity of stone has been crushed from the different fields, which has averaged 1oz. to the ton of stone, whilst alluvial patches of great value are still being worked. Gold also occurs associated with pyrites along the Darling Range, at Kendinup, Bindoon, the Wongan Hills, and the Eastern districts; it has also been found in stone at Yuin and in the alluvial form at Peterwangy, at the head of the Irwin. Gold mining here is in its infancy, not yet being ten years old; but as during this time it has made great progress, especially during the last year or two, there is every prospect that this colony, before long, will be one of the chief gold-producing countries of the world.

Silver.

Symbol, Ag (Argentum); atomic weight, 107·93; specific gravity, 10·5.

Silver has been known and used from the earliest times as currency and for jewellery. In colour, when seen in a mass, it is of a lovely silver white, and may be distinguished readily by an expert from other metals or alloys. Very thin leaves of it, viewed by bright transmitted light, appear to be blue.

The lustre of it is brilliant, and it will take nearly as high a polish as steel. Its hardness is 2·5, but this is increased by hammering or rolling, but can be again softened by heating and gradually cooling, called annealing.

Silver in the metallic state may be distinguished from the other white minerals by not giving off fumes before the blowpipe, and by its solubility in nitric acid, from which solution it is precipitated by common salt in a white precipitate, which blackens on exposure to the air.

It is distinguished from platinum as it fuses, and from lead as it will not mark paper; it does not crackle when put between the teeth, like tin, and is more malleable than most of the other common white metals.

It can be beaten out into leaves $\frac{1}{10000}$ of an inch in thickness, and a grain of it may be drawn into a wire 400ft. in length. This wire is very tenacious; when of a thickness of $\frac{1}{10}$ of an inch it will support a weight of 240lbs. It melts at a temperature of 1800° F., and may be volatilised by the voltaic arc or by the oxyhydrogen blowpipe, when it appears as a bluish vapour. It is the best known conductor of heat and electricity.

Silver has no affinity for oxygen at ordinary temperature, but when in the molten state it absorbs 22 times its own bulk, which is again disengaged on cooling, the mass suddenly becoming incandescent, called flashing.

The black tarnish observed on silver in towns is due to the presence of small quantities of sulphuretted hydrogen in the air, which the silver decomposes, forming a sulphide on its surface.

Silver is too soft to stand much wear, therefore it is generally alloyed with copper, the British standard coinage containing 7·5 per cent. of the latter metal. It occurs in nature in the metallic or native state, alloyed with gold and copper, also in combination with sulphur, silenium, tellurium, arsenic, antimony, chlorine, bromine, and iodine; many varieties of copper, lead, manganese, and iron ores contain notable quantities of it, and it has also been detected in sea water, but has never been found as an oxide, carbonate, sulphate, or phosphate.

The following are the most common forms in which it occurs:—

Argentite.—Silver Glance.—Sulphide of Silver.—This mineral occurs both crystalline and massive. Its lustre is metallic, colour and streak lead grey, hardness, 2·5; specific gravity, 7·10; composition, sulphur, 12·9 per cent., and silver, 87·1 per cent. It is distinguished from copper, lead, and other silver ores by the ease with which it can be cut by a knife, and affording a globule of silver when heated alone on charcoal before the blow-pipe.

Pyragyrite.—Ruby Silver.—Dark red silver ore.—This ore occurs both crystalline and massive of a black to a dark red colour, with a red streak and brilliant lustre, its hardness, 2·5; specific gravity, 5·8; and composition, sulphur, 17·7; antimony, 22·5; silver, 59·8. It is distinguished from any other mineral, as it fuses easily, coating charcoal with a white deposit of antimony, and yields a globule of silver when fused with soda.

Stephanite.—Brittle Silver Ore.—Black silver occurs both crystalline and massive; its streak and colour are both iron black; its hardness, 2·5; and specific gravity, 6·27, being composed of sulphur, 16·2; antimony, 15·3; silver, 68·5.

Cerargrite.—Horn Silver, Silver Chloride.—This is mostly found as incrustations, but also massive, of a grey to greenish colour and waxy appearance. It cuts easily with a knife, the shaving curling up before it.

Its composition is chlorine, 24·7; silver, 75·3; and is easily reduced on charcoal.

Up to the present no silver ores have been discovered in this Colony, and even the lead ores are very poor in this metal, rarely carrying more than 2ozs. to the ton. If silver is found it will probably be associated with copper and iron ores, as at Broken Hill.

At the present time silver is very low in price, so that lodes have to be of considerable richness to pay to work.

Silver is largely used in coinage, jewellery, and for plating goods to preserve them from oxidation; and it is also to this metal that we owe the power of reproducing nature by means of photography, which is due to the fact that light decomposes certain of its salts.

Platinum.

Symbol, Pt.; atomic weight, 194·4; specific gravity, 21·0.

It was discovered in 1744 by an assayer named Woods, in Jamaica, who gave it its name, which means "little silver," from its similarity to that metal.

It always occurs in nature in the metallic state, mostly alloyed with some of the rare metals, and mostly found like gold, with which it is often associated in the form of grains in alluvial deposits. In colour it is from pale to dark steel grey with a metallic lustre; it is both ductile and malleable; its hardness is 4·5, and it is often slightly magnetic. It is easily distinguished from other metals by its malleability and infusibility.

Platinum cannot be melted by any ordinary process, but requires an oxy-hydrogen furnace or the voltaic arc, when it melts at a temperature of 2732° F. This infusibility renders it of great value in chemistry when apparatus are required to stand a high temperature.

It has never yet been found in this Colony, but it may at any time, and will probably be associated with alluvial gold.

The other metals which occur with it, as iridium, rhodium, palladium, and osmium are so rare and occur in such small quantities that they are not worth describing.

Mercury.

Symbol, Hg. (Hydrargyrum); atomic weight, 200; specific gravity, 15·5.

It has been known from very remote times, certain of its compounds being used by the Greeks. In colour it is silver white, and from its resemblance to that metal in colour, and from the fact that it is liquid at ordinary temperature, it has been called quicksilver. It becomes solid at a temperature of 40° F., when it is both ductile and malleable, and starts to volatilise at 66° F., and boils at 682° F. It is easily distinguished from other metals by the fact that it is liquid. Mercury is used largely in gold and silver saving, for silvering mirrors, the manufacture of thermometers, and in medicine under the names of white and red precipitate, calomel, corrosive sublimate, and blue pills; the red colour called vermilion is also a salt of mercury, and it may be here mentioned that all salts of mercury are poisonous. It occurs in nature in the metallic state, mostly alloyed with other metals forming native amalgam, but most commonly as a sulphide.

Cinnabar.—Mercury sulphide.—This occurs both crystalline and massive and earthy, of a bright red to brownish black colour, with a brilliant lustre, its streak being scarlet red.

It is subtransparent to nearly opaque, it hardness being 2·5, specific gravity 9, and its composition sulphur, 13·8, mercury, 86·2. It is distinguished from any other mineral by vapourizing before the blow-pipe. It has never yet been found in this Colony.

Copper.

Symbol, Cu. (Cuprum); atomic weight, 63·4; specific gravity, 8·84.

Copper has been known and worked from the earliest times, and was used as an alloy with $\frac{1}{10}$ its weight of tin in the manufacture of tools and weapons long before iron was worked.

It is of a deep red colour when seen in a mass, and does not oxidise at ordinary temperature in dry air, but in damp air, when acid vapours are present, it becomes corroded with a green substance called "verdigris." It also becomes coated with a reddish-brown oxide when heated in the presence of air, and loses its metallic lustre.

Its hardness is about 3, but this is greatly increased by hammering or rolling.

Its malleability and ductility is less than gold, silver, or platinum, but its tenacity is greater than any other metal except iron.

It melts at a temperature of 1990° F., and when raised to a white heat gives off metallic fumes which colour a flame green.

It is the next best conductor of heat and electricity to silver, and is largely used for the latter purpose owing to the fact that it is much cheaper than silver and is more tenacious.

Copper occurs in nature in the metallic form, but also and more commonly as the following compounds:—

Chalcopyrite.—Copper pyrites, copper and iron sulphide.—This ore is generally met with in depth, sometimes crystalline but most generally massive. It is of a brass yellow colour, and tarnishes deep yellow, which is often iridescent. The streak is non-metallic and shining, of a greenish black. Its hardness is about 4, and its specific gravity 4·15.

Its composition is sulphur, 34·9; copper, 34·6; iron, 30·5.

It is distinguished from gold, as it crumbles instead of cutting, and from iron pyrites, as it can be scratched with a knife. It fuses to a blackish magnetic globule on charcoal, owing to the iron present.

Malachite.—Green carbonate of copper. It occurs as incrustations, botryoidal or stalactites, with a fibrous structure, also earthy. In colour it is green, and generally opaque, but sometimes translucent. Its hardness is from 3 to 5·4, and specific gravity about 4. It is composed of carbonic acid, 19·9; copper oxide, 71·9; and water, 8·2, and will dissolve with effervescence in acid.

Azurite.—Blue carbonate of copper. Found sometimes crystalline, but generally massive and earthy. It is of a deep blue colour, and varies in hardness from 3·4 to 4·5, whilst its specific gravity is about 3·6. It is composed of carbonic acid 25·6, copper oxide 69·2, water 5·2.

The most common ore of copper met with at the surface is a mixture of iron and copper oxide and copper carbonate, resulting from the decomposition of the copper pyrites. The mass is of a liver colour stained with green in patches.

The presence of copper in an acid solution can always be determined by the addition of ammonia until solution is alkaline, when it will be a bright blue colour. The green colour it imparts to the flame is also a reliable test.

Copper ores are found over a large portion of this Colony, but have only been worked in the Northampton and Roebourne districts. Very little is being done at present, owing to the low price of copper, although the ores here are of a very high percentage; the lodes are large, and in neither place is there any great distance to cart.

Copper is used in coinage, alloyed with tin, to form a bronze. It is also alloyed with zinc, when it is called brass; but the most extensive use to which it is at present put is in the manufacture of copper wire, which is largely used for electrical purposes.

The great falling off in the demand for copper is due to iron being used to replace it in ship building, whilst the great fall in price is also due to the discovery of the large lodes in Spain, where labour is so cheap.

Lead.

Symbol, Pb. (Plumbum); atomic weight, 207; specific gravity, 11·35.

Lead has been known and worked from very early times. It is a soft metal of a bluish grey colour, when freshly cut, with a strong metallic lustre, which tarnishes rapidly on exposure to the air, the surface being coated by a layer of carbonate of lead.

It is so soft that it will leave a mark on paper, its hardness being 1·5.

Lead is very malleable and ductile, but its tenacity is far inferior to all the other ductile metals.

It melts at a temperature of about 617° F., and begins to volatilise at a red heat.

It is very easily distinguished from all the other white metals by the fact that it marks paper and is very malleable.

Lead occurs in nature mostly as sulphides and carbonates, but it is also found in combination with several other elements.

Galena.—Lead sulphide.—This mineral occurs either crystalline or massive; its colour and streak are silvery, with a metallic lustre. Its hardness is 2·5, and specific gravity 7·5, being composed of sulphur 13·4, lead 86·6. It generally contains some silver, and often gold, without which precious metals it hardly pays to work at the present time. It is distinguished from silver by its cubical cleavage.

Cerusite—White Lead Ore; Lead Carbonate.—This is found crystalline, fibrous, and massive, of a white or greyish colour and brilliant lustre. It is very brittle, its hardness being 3·5, and specific gravity 6·46, being composed of carbonic acid, 16·5; lead oxide, 83·5, and is reduced with ease to a globule of lead on charcoal.

The other ores of lead are comparatively rare, and seldom occur in large quantities.

Lead was largely used in former times for roofing houses, making tanks and water pipes, but has now been superseded in a large measure by iron, the uses to which it is put at the present being the manufacture of shot, which is made of lead with 0·5 to 2 per cent. of arsenic; type metal is an alloy 4 parts of lead to 1 of antimony, and sometimes a little tin. Stereo-metal consists of lead, tin, antimony, and sometimes bismuth; fine solder, 2 parts tin to 1 of lead; common solder, equal weights of those two metals, and coarse solder, 2 parts lead to 1 of tin; pewter, 1 part lead to 4 of tin; Victoria metal, used for teapots, spoons, etc., is a mixture of lead, antimony, and bismuth with tin.

Lead ores have been found to exist in many places in this Colony, but have only been worked at Northampton, Roebourne, and Cardup, South of Perth, but to no extent except in the first mentioned district. These mines are not now at work, owing to the low price of lead, and to the fact that the lead ores of this Colony carry so little silver.

Antimony.

Symbol Sb. (Stibium); atomic weight, 122; specific gravity, 6·2.

Antimony has been known from the earliest times, as it was used in the form of sulphide by the ancient Greeks to blacken the hair and eyebrows. In colour it is a tin white inclined to have a bluish tinge, its hardness is 3·5, it is extremely brittle, possessing a strongly crystalline structure. It can be reduced to a powder in a mortar. It melts at a temperature of 1150° F., and is slowly but distinctly volatile at a white heat.

Antimony is readily affected by exposure to the air at ordinary temperatures, and is rapidly oxidised when exposed to it in a fused state. It is used in the manufacture of type metal alloyed with lead, as stereo-metal with tin and lead. It and its salts are also largely used in medicine. It occurs in the native state, but is more commonly met with as a sulphide.

Stibnite.—Grey Antimony; Sulphide of Antimony.—This ore is mostly found in the massive state, and is of lead grey colour, brittle, and slightly sectile, having a hardness of 2, and specific gravity of 4·5, and is composed of sulphur, 28·2; antimony, 71·8.

It fuses readily in a candle flame, and is volatilised before the blowpipe, passing off in white fumes.

It occurs at Mallina, about 70 miles to the Eastward of Roebourne, associated with gold and quartz, also in small quantities in several other parts of this Colony.

Zinc.

Symbol, Zn.; atomic weight, 65·2; specific gravity, 6·9.

Although zinc must have been known from very early times, as it was used in the manufacture of brass, no mention of it occurs until 1541. It is a soft metal, of a lead grey colour, and will retain a brilliant surface when cleaned and placed in a dry atmosphere at ordinary temperature, but rapidly tarnishes in a damp atmosphere; at ordinary temperature the metal is brittle, but when heated between 248° and 302°, it becomes both ductile and malleable, but when the heat is increased to 401°, it again becomes brittle, and may be readily pulverised in an iron mortar. Zinc melts at a temperature of 793°, and boils at 1904° F., when it can be distilled over into water. When strongly heated in air it burns with a greenish white flame, producing dense white fumes. A zinc plate, in conjunction with a plate of another metal either in a weak acid or saline solution, generates an electric current, and this property is taken advantage of in all electrical work. Zinc is largely used in a process called galvanising, which consists of coating sheets of iron with a thin coat of this metal, which protects the iron from rusting. It is also used in the manufacture of brass, which is an alloy of one part zinc to two of copper. Muntz's metal, used for sheathing ships, is three parts copper to two of zinc with a small quantity of lead. Pinchbeck, three parts copper to one of zinc. Dutch or Mannheim gold, Tombac, and Aich's metal are varieties of brass. Zinc does not occur in nature in the native state, but most commonly as a sulphide or carbonate.

Sphalerite or Blende.—Sulphide of Zinc (Black Jack of lead miners).—The colour of this ore varies a great deal from waxy yellow to black, sometimes green, red, and white, whilst the streak is white to reddish brown. Its lustre is resinous and brilliant. Its hardness is 3·5, and specific gravity 4, and its composition is sulphur 33, zinc 67. It occurs in this colony, associated with the galena, at Northampton and Cardup, along the Darling Range.

Tin.

Symbol, Sn. (Stannum); atomic weight, 118; specific gravity, 7·29.

This metal, although met with in but few localities, has been known and worked from the earliest times. It is of a silver-white colour, with a brilliant lustre. When heated it emits a peculiar smell, and when bent gives out a crackling sound. It is very malleable. Tinfoil may be obtained in leaves less than $\frac{1}{50}$ of a millimetre in thickness, but it is not ductile. It melts at a temperature of 442° F., and boils at a white heat, giving off fumes. At ordinary temperature it is very little affected by exposure to the air, but in time becomes coated with a dark-brown oxide. It occurs in nature in two forms, as an oxide and a sulphide, the former of which is by far the most frequently met with.

Cassiterite.—Tin Ore; Tin Oxide; Stream Tin.—This occurs crystalline and massive and in grains. It is of a brown or black colour, with a high lustre, its streak being a pale grey or brownish.

Its hardness is from 6 to 7; specific gravity is also from 6 to 7, whilst its composite is oxygen, 21·33; tin, 78·67.

It resembles garnets, titanic iron, zinc blende, and tourmaline, but is distinguished by its infusibility when alone, and by its yielding a globule of tin when fused with soda.

This ore occurs both in alluvial deposits as stream tin and in lodes.

Tin is one of the metals which at the present time is in the greatest demand, owing to the discovery of a process by which sheets of iron can be coated with it, which protects the iron from oxidation or from being attacked by acids when used in canning goods. The tin used in this way is completely lost as far as things can be in nature, for it has been found quite impossible to utilise the recovered tin from old cans owing to the presence of lead in the solder.

Tin is also used to form alloys, 10 per cent. of it with copper being gun metal. Three parts of copper and one of tin form bell metal; one part tin and two parts copper, speculum metal. Bronzes are various mixtures of copper, tin, zinc, lead, and iron, the bronze used for coinage containing 95 parts copper, 4 tin, and 1 zinc. Solder, pewter, and Britannia metal are alloys of tin, copper, zinc, antimony, bismuth, and lead.

Mercury readily dissolves tin, the amalgam being used to cover glass in the manufacture of mirrors.

Tin ore is found in this colony at the Greenbushes Tinfield, and on the Shaw River to the Eastward of Roebourne, whilst small samples are reported to have been found in several places in the Darling Range.

Iron.

Symbol, Fe. (Ferrum) ; atomic weight, 56 ; specific gravity, 7·5.

Iron, although now about the most useful metal, is not supposed to have been worked at as early a period as copper, tin, and the noble metals. This may be accounted for by the fact that iron ores require certain metallurgical processes to reduce them, which were probably unknown to the ancients.

Iron is of a bluish grey colour, with a dull and fibrous fracture, but acquires a brilliant surface by polishing. Its hardness is 4·5 (being one of the hardest metals), it is both malleable and ductile, and possesses the greatest tenacity of any metal. On exposure to the air, particularly damp air, or charged with a little salt, iron rusts quickly, forming a red oxide.

The melting point of iron has not been accurately determined, but is supposed to be about 2780° F. Iron is attracted by a magnet, and if a mass of the metal be placed near a natural or artificial magnet, it becomes magnetic; this magnetism can only be destroyed by heating to redness. Iron is a metal which at the present time it would be very difficult to do without, as steel is a form of iron in which there is a certain percentage of carbon. Every one is so familiar with the uses to which iron and steel are put that it is useless to enumerate them here.

Iron is of the commonest occurrence of any metal in nature, and it is to this metal that the colouring of most of the rocks is due, and no animal or vegetable life can exist without it. Iron occurs metallic, but more commonly in the form of oxides, carbonates, and sulphides; also, the majority of the meteorites which fall are chiefly composed of iron.

Pyrite.—Iron pyrites; Sulphide of iron.—This ore is generally found in cubes through a rock or reef, but is also sometimes massive, and in the form of pseudomorphs of other minerals or organic remains. In colour it is from a bronze yellow to a silvery white, with a metallic lustre. Its hardness is 6·5, being hard enough to strike fire with steel; specific gravity is 5, and composition sulphur 53·3; iron, 46·7.

When pyrites is heated on charcoal it gives off sulphur, and becomes magnetic. It often contains gold in small quantities, when it is called auriferous pyrites; and should therefore be tested for that metal. It is easily distinguished from all the other yellow metallic minerals by its hardness. It occurs throughout the crystalline series in this Colony, and has been found to carry gold wherever tested in the Darling Range. It is always associated with gold on all the fields of the Colony.

Hematite.—Specular Iron Ore; Iron Oxide.—This ore occurs in many forms, rarely crystalline, but mostly massive botryoidal (Kidney ore), micaceous iron ores, red hematite, red ochre, jaspery clay iron, clay iron stone, &c.

It varies in colour from a bright steel grey, through all shades of red and brown, to black, in some cases possessing a brilliant metallic lustre, as in the case of the specular or micaceous ores, but more commonly of a dull earthy appearance, but the streak of all is cherry red to reddish brown.

The specific gravity is about 5, its hardness about 6, and it is sometimes slightly attracted by the magnet. Its composition is oxygen, 30, iron, 70. It is infusible alone, but when heated on charcoal becomes magnetic, which added to the fact that it yields a red powder, distinguishes it from any other mineral. It is of the commonest occurrence in this Colony, but will not pay to work, although there are large lodes of a high class. The only use to which the earthy red form is put here is by the natives, who call it "Wilgie," and with it they colour themselves all over.

The other ores which are met with in this Colony in any quantities are magnetite (magnetic oxide), limonite (brown iron ore); but as iron ores are of no value, it is useless to trouble about them.

Iron in the Metallic form has not been found in lodes. It occurs in the Meteoric form on the sandplains to the Eastward of York.

Tungsten.

Symbol W. (Wolfram); atomic weight, 184; specific gravity, 18·0.

This element never occurs free in nature, its principal native compound being Wolfram, which is a tungstate of iron and manganese. It is of dark greyish black colour, with reddish brown streaks. Its hardness is 5·5, and specific gravity, 7·5.

It is being used in the manufacture of steel shot, which it makes very hard and brittle, also increasing the specific gravity; but although of considerable value for this purpose, such a very small quantity is used that it produces a very false impression when the price per lb. is quoted. In Cornwall alone there are hundreds of tons of it, which have been dressed away from the tin. If there were any great demand for it, the owners of these mines would be delighted to sell it at a very low figure.

Manganese.

Symbol, Mn.; atomic weight, 54·0; specific gravity, 8.

Compounds of manganese are widely distributed; it is never found itself in the native state, but generally occurs in the form of black oxide.

Pyrolusite.—Manganese oxide.—Mostly fibrous, radiating, divergent, massive, or in reniform coatings. Its colour and streak are black and non-metallic, its hardness is 2·5, specific gravity 4·8, and composition, manganese 63·2, oxygen 36·8.

It can be distinguished from iron ores, as it is not so hard, and imparts a deep purple to a borax bead.

It occurs in several places in this Colony, but is not of sufficient value to work, but should be always tested, as it often contains large quantities of cobalt.

It is used in the manufacture of steel and for colouring glass.

Nickel and *Cobalt* are both rare metals, and have not yet been found in this Colony; but should prospectors find samples they think to be ores of these metals, they had better have them tested, as they probably will not be able to do it themselves in the bush.

Aluminum.

Symbol, Al.; atomic weight, 27·3; specific gravity, 2·56.

This element, although forming a large portion of the earth's crust in the form of silicates as clay, feldspar, &c., is never found in nature in the metallic state, in which state it was first obtained in 1828.

It is a light silver colour metal, being both malleable and ductile, melting at a full red heat with no tendency to oxidise.

It alloys readily with many metals forming alloys, one of which is aluminium bronze, which consists of nine parts copper and one of aluminium; this is hard, malleable, and has the colour of gold, and is capable of taking a high polish.

It is the lightest metal known, which, added to the fact that it does not rust, will make it of considerable commercial value.

Corundum (sapphire, ruby, and emery). It occurs mostly in six-sided prisms, but also granular of a blue-greyish, blue-red, yellow-brown, or black colour, being transparent to translucent. Its hardness is 9, specific gravity about 4, and composition, oxygen 46·8, and aluminium 53·2.

Before the blowpipe it remains unaltered, both alone and with soda, and this and its hardness, which is next to a diamond, distinguishes it from any other mineral. Bright, clear crystals of a blue colour are called sapphires, the red ones rubies, the opaque and translucent are called corundum, whilst the earth or where fine particles are intermixed with much oxide of iron it is called emery.

The clear varieties are of great value as gems, for owing to this hardness they retain their polish, sharp face, and their brilliancy for a long time.

Calcium.

Symbol, Ca.; atomic weight, 39·9; specific gravity, 1·58.

Compounds of this element are very abundant and widely distributed over the earth crust as carbonates, sulphates, and phosphates; but it is never found in the metallic state, in which form it resembles gold in colour, and like that metal it is very ductile and malleable; it gradually tarnishes in dry air, and quickly in moist.

It decomposes water, forming a hydrate and liberating hydrogen. It is readily dissolved by dilute nitric acid, but strong has no effect upon it.

Carbonates.—It occurs most commonly in nature as a carbonate, the pure form of which is called calcite, calc spar, dog-tooth spar, Iceland spar, satin spar, and stalactites; but the more earthy varieties, as chalk, limestone, marble, are of the greater economic value for building stones, lime, and cement, some of the latter varieties containing a large percentage of clay and iron, which, when burnt, often possess the power of setting under water, when they are called hydraulic. Calcite and stalactites occur in the caves on the Moore and Hill rivers, also between the Vasse and the Leeuwin. The limestone at Albany, all along the coast in patches from the Leeuwin to the N.W. Cape, at Gingin, Yatheroo, Dandaragan, the Irwin River, near Geraldton and Northampton, all the way North from the Gascoyne to the tableland at the head of the DeGrey, the Kimberley District, and there are also many surface deposits in the interior.

Sulphates.—In this form it is called gypsum, and occurs all over the salt lake areas of the interior, as well as being associated with the carboniferous formation wherever it outcrops.

This mineral, when burnt, forms plaster of Paris.

Phosphates.—No crystalline phosphates have yet been discovered, but it forms one of the most important constituents of guano, which is met with and worked on many of the islands around this coast.

NON-METALLIC MINERALS.

THEIR OCCURRENCE AND USE.

Silicon.

Symbol, Si.; atomic weight, 28.

Silicon, although the most abundant of solid elements, is never found free in nature, but exists in combination with oxygen as quartz, flint, chalcedony, opal, etc. Silicon enters largely into the composition of most rocks; it is also found in the ashes of wheat and grass.

Quartz.

Quartz.—Silicon dioxide.—This mineral occurs in six-sided prisms, but most commonly massive. In the crystalline form it is often quite clear or coloured slightly yellow, when it is called false topaz, slightly purple when it is amethyst, slightly red called rose quartz, smoky and other tints.

It also varies greatly in transparency from perfectly opaque to perfectly clear, being of various shades of yellow, red, green, blue, brown to black. Sometimes these colours are in stripes, bands, or clouds. The hardness is 7·0, specific gravity 2·5, and its composition is oxygen, 53·33; silicon, 46·67; but the composition of the opaque varieties differ, as they often contain iron or earth matter.

Quartz, although varying greatly in colour, may be distinguished by the absence of cleaving, its hardness, infusibility, and its crystalline form.

Besides the vitreous varieties mentioned above, there are the Chalcedonic and Jaspery varieties. The first of these occurs massive, is translucent, with a waxy lustre, in colour usually pale greyish, bluish or brownish, often lining cavities or in the form of stalactites. The apple green variety is called Chrysoprase, a bright red or clear red tint is called Carnelian, a deep brownish, red and red by transmitted light is called Sard. When variegated with colour in bands, clouds, or patches it is called Agate, but when the colours are arranged in flat horizontal layers it is called Onyx. The greenish grey translucent form having an opalescence is called Cats'eye.

Flint and hornstone are massive compact varieties, without any lustre. Chert is an impure hornstone. The Jaspery varieties differ from the others, being opaque, owing to a certain amount of iron or earthy matter. Jasper is dull red or yellow siliceous rock, containing clay and oxide of iron; sometimes the colours run in bands, when it is called Riband Jasper. Bloodstone or Heliotrope is deep green, slightly translucent, with blood-red spots. Lydian stone is a velvety black, opaque, and is used to test the purity of precious metals on.

Opal.

Opal is amorphous, stalactitic, or earthy, and owing to minute cracks in the mass, it often presents a play of colour of many shades. It is white, yellow, red, brown, green, grey, mostly translucent, but some dark varieties are opaque. It has a resinous lustre, its hardness is 6·5, specific gravity about 2·0, and its composition consists, like quartz, of silica, but in a different molecular state, and generally combined with water. There are many varieties of opal, but the precious opal, which is milky with a pale delicate colour, is the only one of much value. Many opals have been found in this Colony amongst the Mesozoic rocks, but nothing of any value up to the present.

Asbestos.

Asbestos is a name given to the fibrous varieties of pyroxene and hornblende. It varies greatly in colour, but the white varieties are the only ones of any value, owing to their infusibility. It occurs in veins amongst the old crystalline rocks, associated with quartz, but has not been found in this Colony of a high enough quality, up to the present, to be worth working. The principal points are the length of fibre, its pliability, and its infusibility.

Garnets.

Garnets occur mostly crystalline of a deep red to black, green or white colour, transparent to opaque, with a vitreous lustre, having a hardness of from 6·5 to 7·5, and specific gravity of from 3 to 4, whilst their composition varies greatly. Most garnets fuse to a black glass, which is magnetic, but the chrome garnets are infusible. Garnets are often mistaken for rubies, but they are easily distinguished by their inferior hardness, and by the fact that all red garnets fuse and blacken.

They are found in many places amongst the crystalline rocks of this Colony, but are of little value without they are of good size and clear.

Kaolinite.

Kaolin, or *China Clay*, occurs in chalk-like masses, either compact, friable, or mealy, having often a microscopic crystalline structure.

It is white when pure, but is also of many shades to dark reddish-brown, and is greasy to the touch, its hardness being 1 to 2·5, and specific gravity 2·4 to 2·6. It is a silicate of alumina combined with water when pure, but when impure contains iron. It is the result of decomposed felspar, and is infusible and insoluble in acids. Pure kaolin makes the fine porcelains, the impure forms earthenware, pipe clay, &c.

Mica or Muscovite.

It is always found crystalline, the crystals of which split into plates and scales, varying in colour from a white to green, yellow, and brown, with a pearly lustre. It is transparent, or translucent, tough and elastic, with a hardness of 2·5, specific gravity of 2·7, with a composition of silica 46·3, alumina 36·8, potash 9·2, oxide of iron 4·5, fluoric acid 0·7, and water 1·8.

Mica is mostly found in nature as a constituent of granitic and other metamorphic and igneous rocks. When it attains sufficient size to be of commercial value, it occurs associated generally with quartz and feldspar as a granite-dyke, in which the crystals of the different minerals are of such great size that it loses all the character of a rock, presenting more the appearance of a lode.

The portions where the mica is of sufficient size to be worth working, occur in bunches or patches, often of considerable extent, along the dyke, but it is a matter of uncertainty whether it will continue of the size in depth.

The surface mica is generally stained by coatings of iron and manganese between the thin plates. This, of course, reduces the value considerably, but should the mica continue in depth, it will be found to be quite solid and clear when taken from below the reach of the atmospheric action, or below the water level. Mica can be worked by blasting, being hand-dressed afterwards, as from its elastic nature it will stand more knocking about than the harder and more brittle minerals, which would be shattered. For export it has to be trimmed up square, and all waste and damaged mineral removed, so that the blocks are ready for splitting on their arrival, and the freight is saved on refuse. Its value depends on size, clearness, and the ease with which it splits.

It occurs in this Colony near Bunbury, Bindoon, the Gascoyne, and on the Pilbarra and Kimberley goldfields, but has not yet been found in large enough plates to pay to work.

Topaz.

The *Topaz* is of a pale yellow, white, green, blue, or reddish colour, transparent to translucent, occurring always in the crystalline state, having a hardness of 8, specific gravity of 3·5, and a composition of silica 16·2, silicon fluoride 28·1, alumina 55·7. It is easily distinguished from tourmaline, quartz, and other minerals, by its brilliancy and hardness. No topazes are known to have been found in this Colony up to the present.

Carbon.

Symbol, C.; atomic weight, 12; specific gravity, 3·5.

Carbon is one of the elements most commonly met with in nature, as besides occurring in the crystalline form as the diamond and graphite, it also enters into combination with other elements to form all organic substances.

Diamond.

The diamond is the purest form of carbon, the colourless varieties leaving but a trace of ash, whilst the coloured ones leave from 0·2 to 0·6 per cent.

They are found as crystals mostly in alluvial deposits, but in one or two places they have been found in the matrix.

The colour varies from colourless to yellow, red, orange, green, blue, brown to black, with a brilliant lustre, transparent, with the exception of the dark varieties, which are translucent. When rubbed they become electric, and some possess a certain amount of phosphoresence. Colourless diamonds are of great value, owing to their hardness and brilliancy, but all the other colours are valuable, even the black, which is used for boring purposes.

Graphite, Plumbago, or Black Lead.

This is usually found foliated, massive, or granular, of a lead-black colour with a metallic lustre. Its hardness is from 1 to 2, and specific gravity about 2·25. It will mark paper, and feels greasy to the touch. It consists of about 95 to 99 per cent. of carbon, is infusible both alone and with re-agents, and is not affected by acid. It is found amongst the crystalline rocks of this Colony in small quantities, but mostly in a very impure state, as at Kendinup, the Lower Blackwood, and Northampton District.

Mineral Coal.

Is massive, of a brown or black colour, opaque, brittle, or imperfectly sectile, having a hardness of from 0·5 to 2·5, and specific gravity of from 1·2 to 1·8.

It is composed of carbon, with some oxygen, hydrogen, traces of nitrogen, water, and earth minerals.

Anthracite.—Glance coal or stone coal.—Is a hard, black, compact variety, with a high lustre, and is often iridescent. Its specific gravity is from 1·3 to 1·73, containing from 80 to 93 per cent. of carbon, and from 4 to 7 of volatile matter, and a little earthy matter. It ignites with difficulty and burns with a feeble blue flame. It is largely used for steam purposes, where a great body of heat is required without much smoke and gas.

Bituminous Coals.—This coal is black in colour, but softer, and not so brilliant as anthracite, with a specific gravity not over 1·5. There is a great variety in the coals of this class, in the amount of oil, coal-tar, or gas they yield. They are divided into caking and non-caking coals; the former, when heated, softens, and burns with a yellow-smoking flame, requiring a great deal of stirring to prevent the fire clogging up, whilst the latter, although they resemble the former in appearance, do not soften but burn away freely to an ash. The chemical difference of these two coals is not understood.

Cannel Coal.—This is a very compact, even textured, dull coal, which breaks with a large conchoidal fracture. It burns readily with a yellow fume without melting, so that pieces of it can be used as candles, from which it derives its name. It contains as much as 50 to 60 per cent. of volatile matter, and therefore is largely used in the manufacture of gas.

Brown Coal.—This is usually of a brownish-black colour, but sometimes resembles bituminous coals so closely that it is impossible to distinguish them. The term has been applied to all coals of a more recent age than those of the great coalfields of the world. The name lignite is sometimes used in the same sense, but it is not strictly correct, except when the coal shows woody structure.

Jet.—This belongs to the same class and resembles cannel coal very closely in appearance, but is much harder and of rather a deeper colour. It is capable of receiving a brilliant polish, so is used in jewellery.

It is now generally admitted that coal is of vegetable origin, having been formed under similar conditions to the peat bogs of the present day, the only difference being that the vegetation was entirely different, so that however long the peats remain buried, and under whatever conditions they go, they will never become bituminous coals, as the oily matter in the latter is due to the large quantity of resinous spores which fell from the great club mosses of the carboniferous period.

True coal of the non-caking class has been found on the Collie River, and a belt of the carboniferous formation extends the entire length of the Colony; whilst brown coals, often of high quality, are found all round the South-West portion of the Colony.

ROCKS.

A short Description of some of the Rocks most commonly met with in this Colony.

The term rock, geologically speaking, is given to all the material which forms the earth's crust, no matter whether soft or hard. Rocks are generally divided into two classes, sedimentary and igneous, but as many of the sedimentary rocks have been so much altered that they closely resemble the igneous, we will divide them here for simplicity, according to their composition, into fragmental and crystalline. The fragmental comprise all the unaltered sedimentary rocks which have been formed from the denudation of pre-existing rocks, the composition of the new rock varying according to the composition of the rock which is being worn away and the condition under which it is deposited; when the finer particles, which would form mud, would be carried further than the coarse sands and gravels. This group of rocks also may be said to include the limestone, as they have been derived from small particles of shell, coral, or the small calcareous shells of microscopic organism.

The crystalline rocks may be either of igneous origin or have become crystalline by long and continual heating without fusion; thus we find crystalline rocks with a well-defined bedding, proving them to be of sedimentary origin.

Fragmental.

Boulders are large masses of rock.

Shingle, gravels, and *pebbles* are smaller, and rounded.

Conglomerate may be composed of any of the former, cemented together. When the fragments are round it is called plum-pudding stone, and when angular breccia.

Grit is composed of coarse sand and small pebbles, either cemented or loose.

Sand is composed of fine silicious particles.

Sandstone is composed of consolidated sand.

Quartzite is a sandstone cemented by silica.

Clay is a soft, more or less plastic, material, chiefly composed of silica and alumina, of almost every shade of colour from white to black.

Shale is consolidated clay. It has an uneven slatey structure, and is of many colours, but mostly dark.

Slate is a stage further than shale, and is found mostly among the crystalline rock, often graduating into mica schist, etc. It is a soft rock, and sometimes breaks into even slates or slabs, when it is of value for roofing and other purposes, but at other times it is massive.

Alluvium is the earthy deposit made by running streams or lakes, especially during times of flood.

Silt is the material which forms the muddy bottoms and shores of bays and harbours.

Limestones are composed mostly of carbonate of lime, and will effervesce with acid. They are compact, dull, of many different shades of colour, varying in structure from earth to semi-crystalline. (See Calcite.)

Magnesian Limestone.—This contains a good deal of carbonate of magnesia, as well as lime, and is generally much harder than limestone, and does not effervesce as freely with acid.

Chalk is a soft white earthy limestone, which will leave a mark on a board.

Travertine is a massive, often nodular, limestone deposited by springs or water charged with lime.

Crystalline.

Crystalline limestones are limestones which have been altered, having a crystalline structure, and vary greatly in colour according to the impurities.

Marble is a crystalline limestone.

Dolomite cannot be distinguished by the eye from marble, but it contains a large proportion of carbonate of magnesia.

Granite consists of quartz, feldspar, and mica, but has no appearance of layers in the arrangement of the mica and other ingredients. The quartz is generally whitish, without any cleavage.

The feldspar is generally whitish or flesh-coloured, and may at once be distinguished from the quartz by its cleavage and surfaces, which reflect light brilliantly.

The mica is in bright scales, either silvery, brownish black, or black, and can be split with a knife.

Gneiss is a hard, compact rock, like granite, but the mica and other ingredients are more or less distinctly in layers.

Syenite consists of quartz, feldspar, and hornblende.

Mica Schist consists largely of mica arranged in layers, with usually some quartz and a little feldspar. This arrangement of the mica causes it to divide easily into layers.

Hornblende Schist.—A dark greenish schistose rock, generally containing some quartz, but often composed almost entirely of hornblende, which is in layers.

Chloritic Schist is of a dark green colour, with a greasy feel, and contains layers of chlorite.

Mica Slate is a slate through which layers of mica run.

Felsite consists mostly of feldspar, with a little fine quartz mixed through it, of a compact, fine, granular structure.

Diorite is a greenish rock containing feldspar and hornblende. It always occurs in the form of dykes.

Soapstone consists chiefly of talc of a brownish, greyish, or greenish colour, feels very soapy, and can be easily cut with a knife.

Serpentine is of a dark greenish coloured rock of a waxy appearance, and can be scratched easily with a knife.

Basalt is a black or greyish black rock with a tackey feel. It is of volcanic origin, occurring either as dykes or flows. It is often full of bubbles, which in some cases have been filled in with silica or calcite, when it is called an amygdaloid.

HISTORY OF THE MINERAL RESOURCES.

The history of mining in this Colony dates back as far as 1842, with the finding of lead and copper in the Victoria District. The discoverer of copper was a man named Thomas Mason, at that time following the humble occupation of shepherd in the employ of the late Mr. James Drummond. He was stationed at Wanderenooka, and there found the deposits which were afterwards worked with success. Mr. Mason sold his find for £100, and a promise of £100 a year and work for three teams, if the parties were successful in purchasing the land, which in those days had to be put up to public auction. The annuity and work were to continue so long as the mine should be working. The company which was subsequently formed did not ratify the £100 a year part of the arrangement; but Mason worked a team on the road drawing copper ore during 1858 and 1859, until he left this Colony for the gold diggings in Victoria.

Several mines were started, and smelting works erected by English companies who worked them at a profit for many years.

The first great check these mines received was caused by the exodus of miners for the Victorian goldfields, and as no other miners were to be obtained in the Colony, and very few would leave England for any other part of Australia but Victoria, the mines were practically closed down. A second attempt was made to work them some years later, but it was not altogether a success, owing to the great fall in the price of both lead and copper, iron having in a great measure replaced copper in ship-building and lead for pipes, tanks, and roofing; not to mention the phenomenonally rich discoveries of copper in South Australia and Spain, which flooded the market.

These mines are now at a stand-still, only sufficient ore being raised annually to ballast the wool ships which call in at Champion Bay, but there is little doubt that many of them would pay if re-opened.

In the year 1846 Mr. Gregory reported the discovery of coal on the Irwin River, and shortly after Captain Roe also reported the discovery of this mineral in the beds of the Fitzgerald and Phillips Rivers, on the South coast, but, unfortunately, in both places the seams proved to be valueless.

After these discoveries so long a period elapsed without any other mineral being found, that a general conclusion was arrived at, which was that this Colony would never be a great mineral producer, and this idea was supported by Mr. Hargreaves who, in 1860, was specially employed to report on the gold prospects of this Colony.

This conclusion is easily accounted for when the geological features of the Colony are examined, as the great gold-bearing belt lays inland, about 200 to 250 miles, and to the Eastward of large sand plains, which had not been crossed except by explorers till recently.

Many small finds of gold were, however, made from time to time all along the Darling Range, and throughout the South-Western portion of the Colony, in which most of the reefs carrying iron pyrites are auriferous.

These finds did more harm than good, as they caused so much excitement amongst the handful of colonists that by the time the reports reached the other colonies they had been considerably added to, which caused them to attract undue attention.

About the year 1882, Mr. Hardman, who was employed to report on the Kimberley District, discovered gold there, which proved to be rich and to extend over a large area, but situated as it is in such an out-of-the-way corner, it did very little good to the settled portion of the Colony.

However, in the year 1887 a gleam of hope shone from the Eastward, just when it was most needed; for what had the Colony to depend on? Kangaroos and sandalwood were getting scarce. The imports exceeded the exports. We could not even compete with the importation from Eastern colonies of flour or meat, both of which had therefore to be taxed, and even then could find a sale.

This was the discovery of gold by Mr. Anstey at Yilgarn, about 200 miles East of Perth, but unfortunately this first and two or three subsequent finds proved themselves to be of no value; fortunately, however, they led to a permanent and payable field being found a few miles further South.

A little later than this, gold was found in the North-West to the Eastward of Roebourne, which proved since to extend over a considerable tract of country. Some rich deposits of alluvial gold were also discovered on the Ashburton River in the year 1889, and a large quantity was sent away in a short time.

Early in the year 1891 some very rich gold-bearing stone was found on the Upper Murchison. A large number of men at once proceeded there, and discovered very many rich reefs and a large quantity of alluvial gold.

The most sensational discovery was made in the year 1892 by a man named Bayley, about 100 miles due East of Southern Cross. This patch has produced a very large quantity of gold, but the one reef has been the wonder of the colonies; whilst another goldfield, called the Dundas, was proclaimed in 1893.

Thus six goldfields have been declared during the last six years, each of which has proved to be rich, permanent, and of great extent, and there is every prospect of even more extensive fields being discovered further to the Eastward.

Rich deposits of tin ore have been discovered both in the Blackwood District, in the South, and the Roebourne District, in the North; and a coal seam of good size, quality, and considerable extent is now being tested on the Collie River, about 30 miles from Bunbury.

This Colony has therefore proved at last to be rich in minerals, and promises in the near future to rank with the other colonies as a mining country.

GOLDFIELDS OF THE COLONY.

GOLD.

Peterwangey Hill.

Gold was found in the year 1868 in the alluvium on the North side of the hill, where the spurs are capped with large deposits of red clay, sand, pipe-clay, and nodular ferruginous clay-stones; judging from its highly waterworn appearance and the fact that the mineral veins of this locality are not auriferous, it has probably been derived from some old stream bed which passed across this country in a different direction and at higher level than the existing rivers. Nothing certain can, however, be stated on this point until the district has been examined in detail and all the old water-courses mapped. The rocks here are mostly granite, with diorite dykes and occasionally quartz reefs of a highly crystalline character; but a few miles lower down the river, and also further to the Eastward, the country assumes a more promising aspect for gold, the rocks being more schistose and contain many nice-looking quartz and ironstone lodes, though none have yet proved to be auriferous.

Kendinup.

At about the same period gold was found at Kendinup, in a quartz reef which contained much iron pyrites. A company was floated and machinery erected, but as the mine did not pay it was abandoned. The rocks in this neighbourhood are crystalline schists, contain many quartz reefs and diorite dykes, both carrying large quantities of iron pyrites, which contain small quantities of gold.

Bindoon.

Next specimens of gold were found in quartz, at Bindoon, and a company was immediately started, which commenced work on a quartz reef containing a great deal of pyrites. They sunk two shafts, close together, on a reef at the top of a hill, for which work it is difficult to assign a reason, as this was not the reef in which the gold had been found, although it was afterwards proved to contain a small quantity. The rocks are slate and schist, with quartz reefs and diorite dykes, both containing large quantities of pyrites.

The Darling Range.

All along the Western face of the Darling Range, South of Perth, there are several immense quartz reefs, containing large quantities of pyrites, all of which carry a little gold.

Taking into consideration the natural facilities for working these reefs, which are situated on the steep face of the hills, often cut through by gullies which flow in gorges 200ft. and 300ft. deep, the water supply, timber, fuel, and good road communication, these lodes should be thoroughly prospected.

THE KIMBERLEY GOLDFIELD.

(*Proclaimed May, 1886.*)

This goldfield, having a proclaimed area of 47,000 square miles, is situated in the North-Eastern corner of the Colony. Its principal diggings and mines are near the Eastern boundary of the Colony, about 212 miles by the telegraph line from Wyndham on Cambridge Gulf, and 304 miles from Derby on King's Sound, in the broken country at the head of the Elvire and Mary Rivers, the main tributaries of the Ord and Fitzroy Rivers.

This goldfield was discovered in the year 1882 by the late Mr. E. T. Hardman, then Government Geologist, who, in 1884, reported on and issued a map of the district, showing the places where gold was likely to be found. These, in every case, proved to be correct; but as most of the alluvial deposits were very thin, no time was lost in sinking, so that a single miner was able in a short time to work out a large quantity of ground, which, unfortunately, led diggers in other parts of the world to believe, from the returns, that the diggings were much more extensive than they were in reality.

The official centre on the field is at Hall's Creek, which is connected with Perth, viâ Derby, by a telegraph line, and there is also a line to the port of Wyndham.

The Adelaide S. S. Co.'s steamers run between Cossack and Port Darwin, calling at Derby and Wyndham about every three weeks; thus connecting this district with the Southern portion of this Colony, the Eastern Colonies, and Singapore, viâ Cossack, and the North-Eastern Colonies, viâ Port Darwin.

The road is now fairly good between Wyndham and the field, a distance of about 250 miles, and is well watered.

This field consists of five main mining centres, extending for a distance North and South of about 90 miles, viz.:—The Panton, at the 180-mile post from


INDIAN OCEAN
KIMBERLEY
GOLDFIELD
SOUTH AUSTRALIA
Denison Plains
DERBY
WYNDHAM
CAMBRIDGE GULF
ADMIRALTY GULF
MONTAGUE SOUND
YORK SOUND
COLLIER BAY
CAMDEN S
KING LEOPOLD RANGES
Browse I
C Bougainville
Troughton I
C Talbot
C Londonderry
C Bernier
C St Lambert
Thurburn Bluff
Osborne Is
Mt Casuarina
Mt Bradshaw
Mt Horace
Mt Bertie
Prince Regents R
Lushingtons Far
Stephen Ra
Augustus Isd
Champagny I
Coronation I
Montgomery I
Mt Hopeless
Mt Forrest
Mt Leake
Mt Broome
Mt Marmion
Mt Anderson
Grant Ra
Mt Hardman
Mt Abbott
Mt Arthur
Mt James
Crossing
Great Antrim Plateau
Mt Timperley
Mt Docarrell
Gregory 1856
Col. Warburton
Joanna Spring
1873
L Isabella
Lady Edith's Lagoon
A C Gregorys Far
1856
Mt Wilson
Mt Muller
Musgrave Ra
Emily S
Ada Sp
Florence Sp
L Lucas
L White
Mary Sp

Wyndham; Hall's Creek, 32 miles South; the Brockman, 10 miles to the South-East; the Ruby, about 15 miles South; and the Dockrell, about 40 miles to the South-West.

The whole line on which gold has been found being about 100 miles in length, running in a North-Easterly direction, but it will probably be found to extend over a much greater length, as rocks of a similar character extend all up the Ord Valley to the Burt Range.

The Panton.

Between the 180-mile post on the telegraph line and the Panton River Crossing, which is five miles further South, a fairly rich patch of alluvial diggings was discovered along Grant's Gully and the Dead Finish Creek.

Looking to the South and South-East from the telegraph line, a large flat or basin, about five miles wide, is seen to extend in the direction of the Panton River, covered with low rounded hills of clay slate, the whole being surrounded by high rough hills, with the huge razor-backed feldstone dyke, called the Mackintosh Hills, which run North and South, ending abruptly to the Westward. The gold obtained here was of a very good quality, but very little work is now being done on this part of the field, as most of the rich deposits in the creek beds have been worked out.

There are two series of reefs on this field, the first of which, striking North-East and South-West, consists of true veins. Although small in size, they can be traced for a considerable distance at the surface, and it is on this series that most of the claims were taken up. The second series appears at the surface as large quartz blows, striking East and West, cutting across the smaller veins, but they cannot be traced for any distance at the surface, and up to the present gold has only been found in one reef at the extreme Western edge of the field, close to the Mackintosh Hills; but it is highly probable that others will also prove auriferous at their intersection with the smaller rich reef.

These reefs are often accompanied by veins of calcite, mostly massive, and a large quantity of good water is met with at a comparatively shallow depth, whilst the rocks are clay slate and schists, having much the same strike as the true veins.

Great difficulty will necessarily be experienced in working these reefs, as they are mostly small; the stone, although apparently rich in gold, contains so many other minerals from which it is difficult to separate it, and the large amount of water in depth will require extensive pumping plant to keep the mines dry. On the other hand, the stone is of a very promising character, the reefs are well defined, and give every promise of going down, and on one or two of the areas the reefs are large enough to work economically. There is a large supply of good water and plenty of timber close at hand both for mining purposes and for fuel.

The Duffer Rush.

This small field is situated about half-way between the Panton and Hall's Creek. From the little information which can be obtained about these old workings, they do not appear to have been very good.

Mount Coghlan.

A little to the North-East of these diggings a reef was taken up, as some very rich specimens of gold-bearing stone were found, but it has been abandoned for want of capital.

Hall's Creek.

Hall's Creek is 212 miles by the telegraph line from Wyndham, and 304 miles from Derby; a little below the township it flows into the Elvire, which in its turn discharges into the Ord River.

The gold diggings, which were very rich here, followed a narrow North and South belt of country to the Westward of the township, along the side of a feldstone dyke, which forms a long steep ridge running a little East of North.

The country between this ridge and the Albert Edward Range, which latter presents a flat-topped appearance from a distance, consists of a series of low, broken, rough hills, of clay slate and schist, with numerous quartz reefs and basalt dykes, over the whole of which a little gold can be found; whilst to the South-West, there is a small open stretch of alluvial country, beyond which the bold granite hills rise. Very little prospecting has been done in this latter direction, but it is highly probable that some rich deposits may exist in the deeper ground, as it is in the heart of this rich gold-bearing tract.

The reefs which carry gold are mostly small, but make here and there into large rich bunches. None of them have the appearance of being true veins, but simply "gash" veins, caused by the intrusion of the large dyke to the Eastward. They have no walls worth speaking of, follow no regular course, cannot be traced for any distance at the surface, and pinch out in many cases, in depth. It is extremely questionable whether any of the reefs will pay to work permanently out. There is not the least doubt but that the gold in the gullies was derived directly from them.

The water-level at Hall's Creek itself has not yet been determined, as until lately water has always been standing in the pools.

The Brockman.

About 10 miles to the South-Eastward of Hall's Creek, on Butcher's Gully, which is a tributary of the Black Elvira, are the Brockman Diggings. Here, as at Hall's Creek, the rich belt of gold-bearing country is narrow, but extends for three or four miles in a North and South direction.

Very little is now being done in the way of alluvial work, but several leases and claims have been taken up on the reefs, some of which are still being worked.

The country is rough, the main feature being the large quartz reef which forms the main hill ridge of this part, attaining an elevation of as much as 300 feet above the low surrounding country, and it is upon this that most of the principal mines are situated, only a few being situated on a line which is on a lower ridge further to the Westward.

A large water supply can be obtained in this belt of country, at a depth of from 30ft. to 50ft., but, as a rule, the wells have not yet been sunk deep enough to obtain enough for continuous crushing.

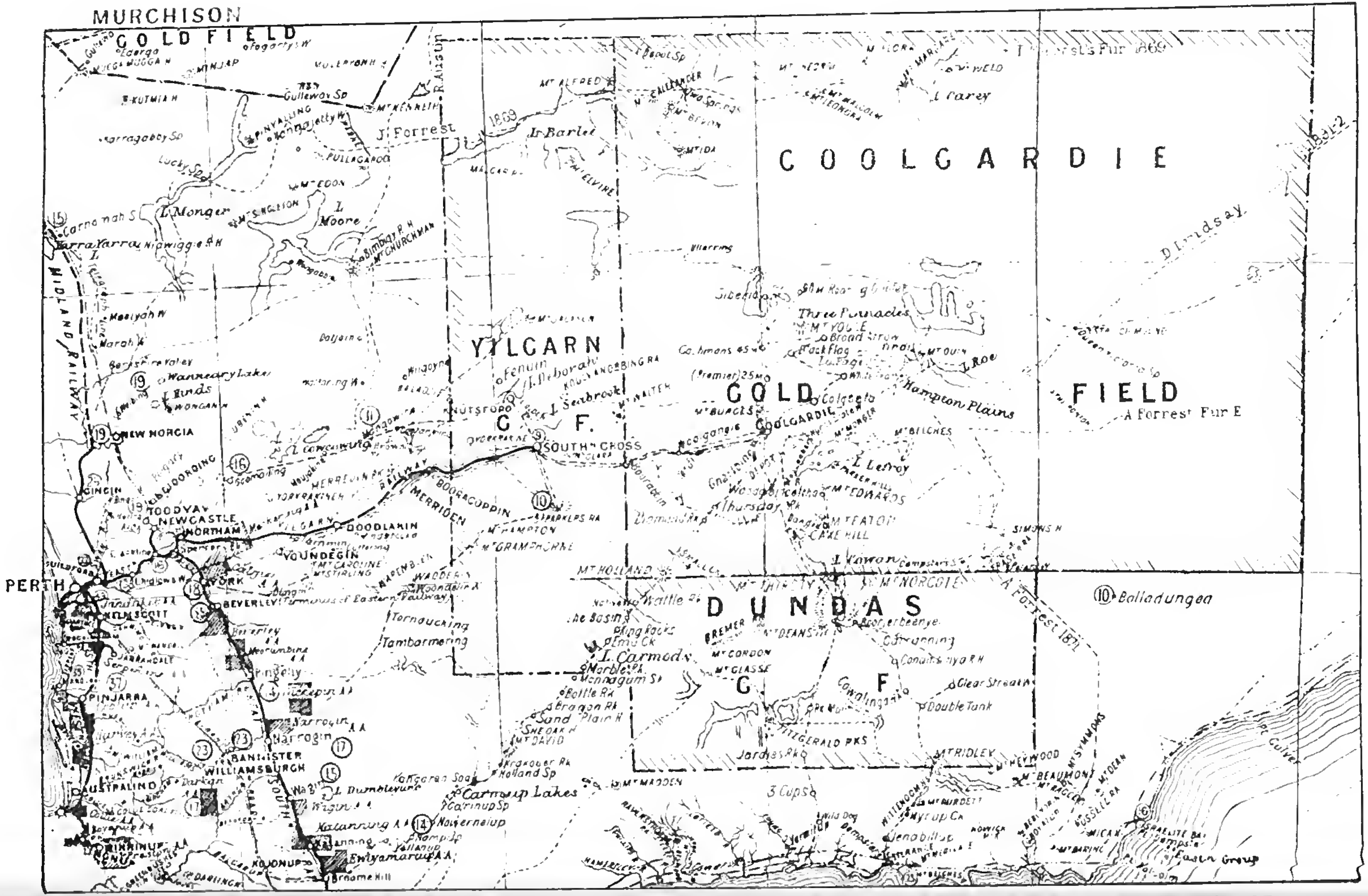
The Ruby.

This field is about five miles in length, mostly on one main line of lode. Large quartz reefs form the main hills, running nearly North and South, with the flat-topped Albert Edward Range close to the Eastward, whilst to the Westward there is a belt of very rough slate and quartzite country.

Most of the leases and claims have been taken up in a continuous line for a distance of over three miles.

As a whole this field is very promising, considering the size of the reefs, their defined character, the ease with which they can be worked and the gold can be extracted from the stone, the length of outcrop along which gold has been found, and the quantity of good water, timber and fuel.

Some mines are still being worked by the miners themselves, who raise stone and stack it until there is sufficient water to work the batteries, both of which on this field crush for the public; but as this way of working is very expensive, only the very rich stone is picked out.


MURCHISON
GOLD FIELD
COOLGARDIE
GOLD
FIELD
YILGARN
G. F.
DUNDAS
G. F.
PERTH
MIDLAND RAILWAY
NEW NORCIA
TOODYAY
NEWCASTLE
NORTHAM
YORK
BEVERLEY
PINJARRA
BANNISTER
WILLIAMSBURGH
SOUTH CROSS
COOLGARDIE
DOODLAKIN
YOUNDEGIN
MERRIDEN
BOORACOPPIN
Hampton Plains
Three Pinnacles
L. Monger
L. Moore
L. Lefroy
L. Carmody
L. Carey
L. Roe
J. Forrest
A Forrest 1871
Balladungea
Carmup Lakes
Narrogin

The Mary River.

On the large plains at the head of the Mary River some of the largest deposits of alluvial gold were found; these are still being worked when there is any water. One of the curious points about this part of the field is that gold was found associated with calcite, and even in the spar itself. It is highly probable that in this neighbourhood some very good reefs will be found that are at present covered by the more recent deposits.

Mount Dockrell.

About 70 miles to the South-West of Hall's Creek, and three or four miles to the South-Western side of the Mount, some very rich deposits of gold were found in the deep gullies, which led to certain reefs which cross them being prospected. The richest of them was taken up; it was a rather curious reef, the rich part of the lode consisting largely of galena, in which free gold could be seen.

There are many other promising reefs around here which cross the gullies in which large quantities of alluvial gold have been found.

Water and fuel there are in abundance, and the well-formed and highly-mineralised character of the stone promises well for its permanency in depth.

Christmas Creek.

For 40 miles to the South-West alluvial gold has been found rich enough to pay to work.

Prospects of the Kimberley Field.

Considering the extent of this field, the size, well-defined character of the lodes, their richness, and length that they carry gold at the surface, the comparative cheapness with which they can be worked, and the good supply of wood and water, there is every reason to predict that it will eventually become an important reefing district, the only drawback being at present the want of capital.

In Conclusion.

It is absolutely impossible to estimate the quantity of gold raised, as at the start there was an export duty on gold; most of it, therefore, was smuggled out of the Colony, but it must have been very large, as all the diggers agree that the field was very rich.

The gold is mostly of a low value, realising at the Mint in Melbourne about £3 11s. 6d. per oz.

Authentic returns clearly prove that the reefs worked are payable; and it was only in a few instances, where small quantities of stone were crushed, that it was picked. The larger crushings, taken as a whole, would return about 1oz. to the ton of stone, which should pay handsomely.

YILGARN GOLDFIELD.

(*Proclaimed November, 1888.*)

In 1887 Mr. Glass, of Mugakine, while making a tank near his house, found a large speck of gold, which caused him to start prospecting, but although he sank several holes he never had the good fortune to find any more. However, the discovery drew attention to this district, and led to a party being organised and fitted out by the Settlers' Association, with assistance from the Government, to thoroughly prospect the district to the Eastward of Newcastle and Northam, This party was placed under the leadership of Mr. Colreavy, who worked over all the country between Newcastle and the Yilgarn Hills, a distance of some 200 miles, and although his first journey was not crowned with success, yet he thought so highly of the country further East that immediately afterwards he set out to prospect it on his own account.

While this latter party was still in the field a sensation was caused by the sudden return from Yilgarn of Mr. Anstey, with some surprisingly rich specimens of gold, in quartz. This gentleman had gone in the same direction as Mr. Colreavy, with the intention of making an extensive prospecting and exploring tour. The excitement in consequence of his find was for some time very great, but it was found, unfortunately, that the discovery was not as valuable as had been at first supposed, as further prospecting showed that, although the surface indications were good, the reef at a very slight depth pinched out. Fortunately, just at this time, Mr. Colreavy, who was prospecting Golden Valley, ten miles further South, struck a small reef, which carried gold throughout the stone, which caused another rush, and several small gold-bearing reefs were found. Prospecting was continued still further, when the "Phœnix" party discovered a rich series of reefs about thirty miles to the South of Golden Valley, which they named Southern Cross, from the fact of having made use of that constellation as a guide while travelling by night to the spot. Mr. Parker, following the same direction for forty miles further South, discovered in some low hills other reefs, which locality he named Parker's Range.

In the year 1892 prospecting was carried on further to the Eastward towards the Hampton Plains, and at a place called Coolgardie, about 100 miles East of Southern Cross, Mr. Bayley found a very rich reef, which has eclipsed all previous discoveries. Many other rich reefs and patches of alluvium have been discovered in a Northerly and North-Easterly direction from Coolgardie for a distance of 90 miles, but the great drawback to prospecting in this district is the scarcity of water.

The first belt of auriferous country is situated about 160 miles to the Eastward of the township of York, in about 119° East longitude. The country on this Eastern side of the Darling Range consists mostly of undulating sand plains, clays, loam flats, with bold bare granite hills, rising abruptly from them. It is comparatively elevated, being between 800 and 1,000 feet above the sea level, but present no marked features; there are no water-courses worth mentioning, the country being comparatively level, and all the highest ground is sand plain, into which the water sinks. The only places where there are any small water-courses are round the granite rocks, but these spread out on the flats and clay pans, where the water evaporates, as there is not sufficient fall to cause it to run towards the coast.

Most of the water met with in sinking is salt, with the exception of the soakages near the granite outcrops and to a certain depth on the high Metamorphic ridges. This latter is due to the fact that rain falling upon these high points would soak away, carrying with it quantities of soluble salts, so that in the course of time rendering the country fresh, whilst on the lower ground just the reverse takes place, as not only do the salts in the ground remain there but more is brought down from the higher ground by the water.

Immediately to the Eastward of this belt of country are the Yilgarn ranges of Metamorphic rock containing numerous quartz reefs and ferruginous lodes, some of which have proved to be very rich in gold.

The country is comparatively low and broken, being situated along the sides of the so-called lakes which drain a large portion of the interior, the denuding action in forming these lakes having removed the sandstone formation, exposing the older rocks beneath.

The rocks on this line of gold-bearing country are mostly slates and schists, with here and there dykes of granite and other intrusive rocks. The reefs are, as a rule, large, and extend to a great length on the surface, but they are not well defined, and seldom have walls on both sides, one side generally splitting up into a large number of leaders, most of which are rich in gold. The stone itself is solid, and of a quartzite nature; it contains a little carbonate of iron, both iron and copper pyrites, galena, manganese, talc, and chlorite, but not in sufficient quantities to interfere with the extraction of the gold. As a rule the stone is very rich, and the crushings that have been made prove that there is, at any rate in one or two claims, a large body of stone carrying more than an ounce to the ton.

Gold is also found on this field in a great dyke-like mass of a greenish colour, probably decomposed serpentines.

Gold-bearing reefs have been found for a distance of over 80 miles from North to South. In some ways the very largeness of the field has been a drawback to the immediate development of the mines, the interests being divided and scattered, instead of being concentrated on the thorough working of a portion, which would have led more quickly to a recognition of its importance by the world at large.

This auriferous belt of country probably extends from Lake Anneen to the South coast, being from 5 to 10 miles in width; and when the development of the field is assisted, as it very shortly will be, by a railway which is now under construction, and when steps have been taken to remove all fears of a failing water supply, then the field should be capable of supporting a very large mining population.

Some small but rich patches of alluvium have been worked on this field, but owing to the want of water the dirt had to be dry-blown.

As so little denudation has taken place since the Metamorphic rocks were exposed at the surface, along this belt, there is not much prospect of this proving a regular alluvial field, but rich surface patches of heavy and specimen gold are certain to be found.

Golden Valley.

The most Northern portion of the field is called Golden Valley, the mines being situated in a small valley, which runs North and South.

The rocks here are very hard hornblende schists, with small quartz reefs and large ferruginous and jaspery quartz dykes, the former of which carry gold. The quartz is of a granular character, often almost approaching a sandstone, and contains in places large quantities of iron pyrites, whilst some of the small rich offshoots contain a great deal of copper pyrites.

The lodes which have proved auriferous form three lines, the Eastern and Western being both small and poor in gold, and, to judge from the formation, are probably legs or branches of the same lode, as the country here forms a sharp anticlinal fold, the junction cap having been denuded. These reefs contain little mineral, and the gold is in a very fine state through the stone, but they are rather small in size to pay.

The other line was discovered between these two at the centre of the valley, and did not outcrop at the surface at all. It was immensely rich at the cap, which consisted mostly of gossan, often copper-stained. This reef splits in two, one branch dipping West and one East. The Eastern one seems the best formed, and has been opened up to a considerable depth, where it consists of white quartz with pyrites, whilst in the country between the two branches there are numerous leaders containing a great deal of copper pyrites rich in gold.

The Eastern branch has been followed for a considerable depth, and proved very rich, showing gold freely all the way down; but it takes a most irregular course, turning and twisting about, and apparently cutting out in places only to make again into a larger mass of stone.

These reefs are undoubtedly rich, and carry gold in depth, but owing to the hardness of the ground and the quantity of pyrites they contain will need to be richer than the reefs on the other part of the field.

No water has yet been struck in the shafts, the battery being run with water pumped up from a well at the bottom of the valley, which although not very salt does not yield enough water to keep the battery going. It is a pity that a shaft was not sunk in the mine itself, as a good supply of water is sure to be struck, and there is no reason why it should not be fresh, if not fresher, than that in the well.

Hope's Hill.

Hope's Hill is about 30 miles South of Golden Valley, the lode here forming the main ridge of the country running North and South, and gradually rising from the lake level at the South end to about 200 feet above it at the North end.

The quartz on the main hill is of a white hungry-looking character but carrying fine gold in the stone and clay partings, particularly on the East side of this reef, in a white magnesian clay, full of quartz grit. On this side of the reef there is a mass of whitey-brown and greenish-blue banded clay, probably resulting from the decomposition of a serpentine rock, full of small quartz leaders, of a curious gritty nature. These leaders are, as a rule, rich in gold, and in some parts gold is also met with along the joints of the clay, but for the most part it is not visible, though on crushing good results are obtained. The bulk of the reef is a white stone of barren appearance, though here and there are bands containing iron, which yield, on crushing, very good prospects of gold. The reef, which is about fifty feet wide at the surface, seems to be in reality a series of reefs separated by partings or casings of a white greasy clay. The richest stone is found in the mass of leaders to the East of the reef; but the main portion is useful for crushing with the mullocky portion.

To the Southward this reef decreases in size, but there still the same size patches of stone are met with, but the clay becomes more solid, and presents more the appearance of a decomposed dyke of a greenish tinge, the gold often being met with on the faces like thin paint. There is an enormous lode formation, with shoots of stone first on one side of the lode then on the other: these, had they been picked, would have yielded good returns, but as it was considered more economical to crush the whole of the lode stuff taken out, the crushings have been low, but this system will cease when the work of development is complete. No water has yet been struck in the mine, as the water level is some 100ft. below the level now being driven into the hill.

This reef, owing to the fact that it rises up out of the plain, could be easily and cheaply worked, and considering the great mass of stone which carries gold it would pay well to work on a large scale.

Near the lake there are some pyrites lodes which contain a good deal of gold, but lodes of this class would be more expensive to work.

Southern Cross.

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

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

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

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

The Eastern is the main line on which the principal mines are situated. It is of a large size, and the quartz is thoroughly mineralised, but does not contain any minerals which will interfere with the abstraction of the gold.

The general description of the lode mass is, a large inter-bedded lode, well formed in the deeper ground, between two good walls, striking a little to the West of North, and dipping at an angle of about 80 deg. to the westward.

This mass varies in width from 5ft. to 30ft., but it rarely consists entirely of stone, especially in the larger portions, where a series of lenticular masses of quartz are met with, the rest of the lode being composed of broken country intermixed with smaller veins and leaders of quartz. These quartz masses often extend along the line of reef for 100ft., and are generally the richest portion of the lode, and are sometimes met with on one wall and sometimes on the other.

The stone is of a highly mineralised character, containing a small quantity of galena, pyrites and chlorite, the latter often giving the stone a greenish appearance.

These reefs are often a good deal iron-stained at the surface, with red clay partings and walls, the foot wall being well formed, whilst there is at the upper part of the lode no hanging wall, but the reef splits up into numerous veins and leaders, which strike away into the country. The rich portions run in well-defined shoots, but it is also rich enough in gold throughout the reef to pay if worked on a large scale.

At the Northern end of this line the reef seems to split into two branches. In the Eastern one there is a great deal of serpentine, which is often very rich in gold. The stone from this line, when crushed, has always averaged one ounce to the ton of stone, so they have proved so far payable.

The ferruginous line contains a large quantity of jasper, and some very rich specimens were found at the surface, but nothing much has yet been done to test this line in depth.

The Western line is evidently a decomposed dyke, and in one place contained some very rich stone in patches for a considerable depth, but little has been done on it yet.

Large quantities of rich specimens were found along these two last mentioned lines at the start of the field, but the claims were abandoned either for want of funds or through bad management; they should, however, be well worth prospecting again.

Blackborne's.

This is situated on comparatively high ground about five miles to the South-Eastward of Southern Cross, and is close on the edge of the large belt of granite country.

The reefs here dip to the Eastward, or in the opposite direction to those on the other parts of the field. They are small but very well defined, and carry gold through the stone in defined shoots.

Jacoletti's.

This is situated about 20 miles to the Southward of Blackborne's, and about five North of Parker's Range. Here several areas were taken up, as some very rich surface specimens were discovered at the cap of a reef.

Parker's Range.

There is another rich reef, about 15 miles South of Jacoletti's, on a small range of schistose rocks to the Western side of a large salt swamp or clay-pan. There are several lines of reef, but most of the claims have been taken up on one which runs in a North and South direction, dipping to the West.

These reefs contain more pyrites than those at the Southern Cross, but this is only seen below the water level, for near the surface it is decomposed, thus liberating the gold, which stores freely in the stone.

About five miles South there are another series of reefs, which are as a rule small but well defined, carrying rich shoots or patches of gold.

The whole Yilgarn field seems to follow one anticlinal fold in the country, the centre of which is exposed at Golden Valley, where the reefs dip both East and West, where the country is hard and the stone carries much copper. Hope's Hill and Southern Cross are on the Western side of this fold, whilst Blackborne's is on the other side of a synclinal still further West, where the reefs dip to the East. All along this line of country the stone is highly mineralised, containing carbonate of iron and chlorite.

At Parker's Range the reef again dips West in pretty firm country, the stone containing a great deal of iron pyrites (mundic), which will carry the gold in depth.

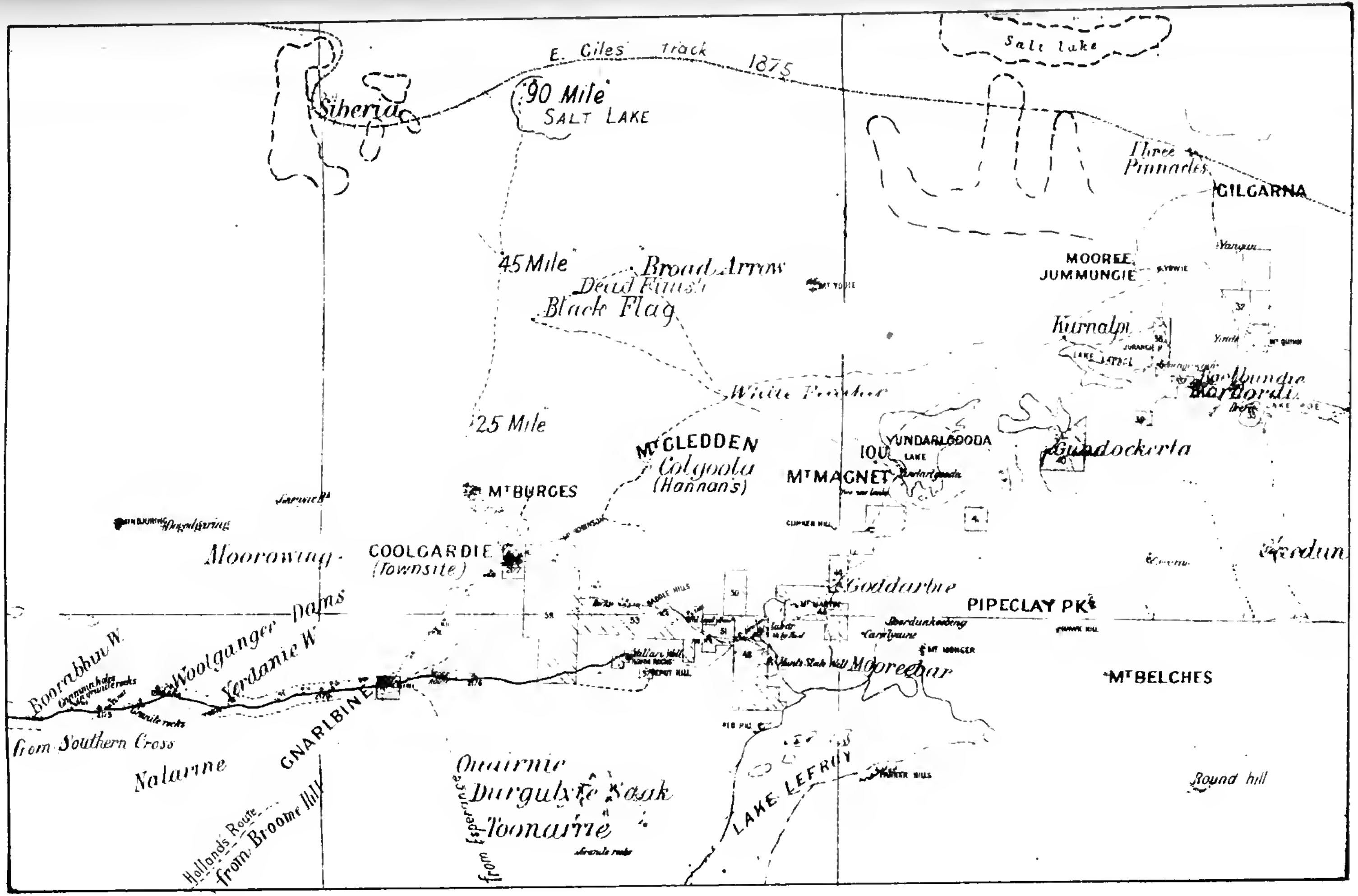
Taken as a whole, the fields have lately made great strides towards development. Up to the present nearly all the reefs tested have proved good, and promise a bright future for the Yilgarn Goldfield.

The great drawback to the rapid development of the field has, up to the present, been the scarcity of fresh water; but this want has now been, in a great measure, overcome (an extensive series of tanks having been sunk by the Government), and also by the provision of a public condenser; not to mention that every mine on which machinery has been erected is in a position to supply itself by means of its own condenser, an apparently unlimited supply of salt water having in almost every instance been encountered at no very great depth from the surface.

Between Southern Cross and Gnarlbine, with the exception of a small belt of Metamorphic country 25 miles to the Eastward, all rock outcrops are granite. Immediately to the Eastward of Gnarlbine there is another small belt of auriferous country, on the Eastward side of which the granite again outcrops and extends as far as Coolgardie.

Coolgardie.

At Coolgardie a rich patch of alluvial ground was discovered in the year 1892, which, since then, has been turned over several times. Up to the present no deep ground has been discovered, a good deal of the gold being found on the surface, as on the Murchison. Several auriferous reefs have been found, but the gold in the alluvium has been apparently mostly derived from rich leaders. On this field the most sensational discovery is a reef found by a man named Bayley, and from his Reward Claim a great quantity of gold has been taken. This reef consists of a small blow running in a North-Westerly direction and underlying to the North-Eastward, striking across the line of the country, which here runs nearly North and South. This reef is about nine feet in width at its largest part, but it pinches


E. Giles' track 1875
Salt Lake
Siberia
90 Mile
SALT LAKE
Three Pinnacles
GILGARNA
45 Mile
Broad Arrow
Dead Finish
Black Flag
MOOREE
JUMMUNGIE
Kurnalpi
White Feather
25 Mile
MᵗGLEDDEN
Colgoola
(Hannan's)
IOU
YUNDARLGOODA
LAKE
MᵗMAGNET
Gundockerta
MᵗBURGES
Moorowing
COOLGARDIE
(Townsite)
Goddarbie
PIPECLAY PKˢ
Dams
Woolganger
Yerdanie W
Boorabbin W.
Mooreebar
MᵗBELCHES
from Southern Cross
Nalarrne
GNARLBINE
Quairnie
Durgulzie Soak
Toonairre
from Esperance
LAKE LEFROY
Round hill
Hollands Route
from Broome Hill

towards either end of the claim, where it is entirely lost. At the North end there is another blow of quartz, which strikes North and South, following the line of the strike of the country. This blow then dips under the alluvial flat, but a reef on exactly the same line is met with in a shaft in the gully, after which it appears to be lost; but to the North-Westward is another large blow, which follows exactly the same bearing as Bayley's reef. At the North end of this blow it pinches out, but on the Western side of the gully is another large quartz blow, which is exactly on the same line as Bayley's, but between which there is apparently no direct connection. At the South end of Bayley's the reef is lost, as at the North, but to the Westward, on a hill, another lenticular mass of quartz carrying gold is met with. From the general character of the reef, it appears to be a true fissure vein, making in size when it follows its true course across the strike of the country, and pinching often to a mere thread when it follows the bedding plane of the rocks. These breaks in the lode may, of course, be entirely due to faults or throws, but the blow at the North end of Bayley's claim and the reef in the gully seem to prove the former theory. All the gold from this reef has been taken from a small shoot at the North side of the blow, where there appears to be a small vein consisting almost entirely of gold associated with a little oxide of iron. There were also some handsome specimens of gold in quartz, and some portions of the reef carry a good deal of fine gold. It appears to be the top of a rich shoot, but it cannot be expected to continue so phenomenally rich much longer, although it may pay well to work. There are several well-formed reefs showing gold about five miles further South, and several other patches for 90 miles to the North and North-Eastward. The available land for prospecting in the immediate neighbourhood of Coolgardie is limited, as this belt lies between the granite country and the freehold land of the Hampton Plains Company; but during the winter we shall probably hear of new discoveries to the North-Eastward, and Southward. When we consider the quantity of gold taken from Coolgardie outlying rushes, it is highly probable that some of these reefs will turn out very good payable mines.

Wongan Hills.

In the year 1888, Mr. Paine discovered gold in these hills, which are situated about 60 miles North-North-East of Newcastle. They appear from the Westward to be two or three isolated peaks, but on approach these are found to be the highest points, and to form the abrupt termination of a range, which runs in a North-East direction. They are flat-topped hills, presenting a bold escarpment to the South-West of about 300ft. above the surrounding clay flats; this face is probably caused by a line of fault, which would also account for the springs near their base.

The rocks are metamorphic and crystalline, with veins of radiated actinolite and small quartz veins. These rocks strike North-East and South-West, following the direction of the range, dipping at an angle of 60° to the North-West, and making their appearance again in a small hill to the North called the Little Wongan. Granite rocks form the low ridges to the North and South; they are often almost covered by sand or ferruginous conglomerate.

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

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

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

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

Quartz reefs in this district are quite a rarity. They are small, of a yellow glassy appearance, containing either pyrites or brown hematite and a little gold. They are well-defined walls, dipping at an angle of about 65° in a North-West direction, following the strike of the rocks North-East and South-West. When opened, some very good specimens and prospects, both from the reefs and the casing, were obtained.

The size of the reef is unknown, as, owing to the hard nature of the ground, and to the discovery of many richer reefs at Yilgarn, it has been abandoned.

PILBARRA GOLDFIELD.

(Proclaimed July 1889).

Proclaimed Area, 32,000 Square Miles.

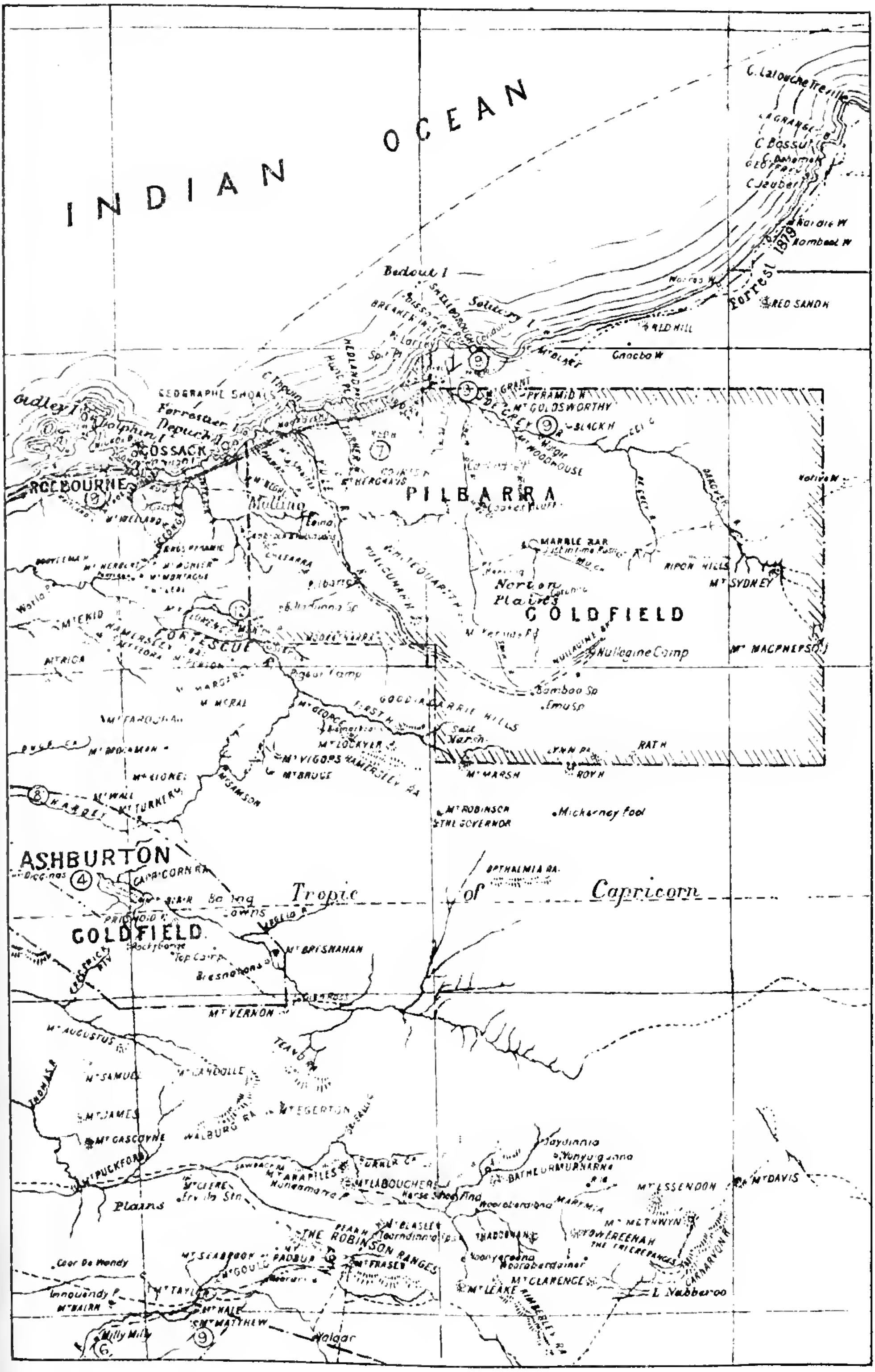
The Pilbarra goldfield is situated in that portion of the Colony known as "The North-West," that is, the district lying between the coast on the North, the Fortescue River on the South, and the De Grey River and Warburton's Great Sandy Table-land on the East. It is a most promising mineral area. The general features are 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 their 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 North and North-West 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, with here and there bold massive hills of amygdaloid and small peaks of quartz, granite, and ironstone, around which soft calcareous slates often rise to the surface but never form hills much above the level of the plain. These plains extend to the sea coast, where they are fringed by mangrove swamps, except where trap rocks extrude and form a bold rocky coast. The amygdaloids in many places are 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 well worth prospecting the streams running through them for precious stones.

MALLINA.

Mallina is between 65 and 70 miles to the Eastward of Roebourne, and about 16 miles South from the coast. It was here that the first discovery of gold in the North-West was made, in the year 1888, when a boy named Withnell picked up a piece of stone to throw at a crow and noticed the gold in it.

Here the gold is associated with sulphide of antimony, and in parts it is very rich, but the portion of the reef which carries much gold is small, although the reef itself is of great size.


INDIAN OCEAN
C. Latouche Treville
C. Bossut
C. Jaubert
Bedout I.
Forrest 1879
RED SAND H.
RED HILL
PYRAMID H.
MT GOLDSWORTHY
BLACK H.
MT WOODHOUSE
Gidley I.
Dolphin I.
Forrestier I.
Depuch I.
COSSACK
ROEBOURNE
PILBARRA
MARBLE BAR
Norton Plains
GOLDFIELD
Nullagine Camp
RIPON HILLS
MT SYDNEY
MT MACPHERSON
FORTESCUE
Bamboo Sp.
Emu Sp.
MT MARSH
MT LOCKYER
MT VIGORS
MT BRUCE
HAMERSLEY RA.
MT ROBINSON
THE GOVERNOR
Mickerney Pool
ASHBURTON
GOLDFIELD
CAPRICORN RA.
OPTHALMIA RA.
Tropic of Capricorn
MT BRESNAHAN
MT VERNON
MT AUGUSTUS
MT SAMUEL
MT JAMES
MT GASCOYNE
MT EGERTON
MT PUCKFORD
MT LABOUCHERE
MT ESSENDON
MT DAVIS
MT METHWYN
THE ROBINSON RANGES
MT FRASER
MT GOULD
MT CLARENCE
MT LEAKE
CARNARVON R.
L. Nabberoo
MT TAYLOR
MT NAIRN
MT HALE
MT MATTHEW
Milly Milly
Yalgar
Plains

There is a good supply of excellent fresh water in this mine, and there is plenty of timber close at hand.

Peewah.

About ten miles distant, to the Eastward, on the Peewah Creek, is another series of auriferous antimony lodes; although some of them are undoubtedly very rich, very little has been done with them, the superior attraction of alluvial mining having taken all the labour away.

Egina.

Thirty miles South-East of Mallina, and 40 miles from the coast, is situated the rich patch of alluvial workings known as Egina. Gold is obtained in shallow alluvial deposits on a clay slate bottom, and some very nice little gutters have been satisfactorily worked.

Pilbarra.

The next patch of workings is situated at Pilbarra, which is twelve miles South-East of Egina, and eight miles West of the Yule River. Here there is a narrow strip of country, about two miles wide, running in a North-East and South-West direction, between a belt of granite country and a ferruginous quartz dyke, the gold being found in rich scattered surface patches. The gold is very little water-worn, and often still adhering to its quartz matrix; but although many of these patches were excessively rich, and numerous quartz reefs are exposed, nothing except alluvial workings has as yet proved payable.

Coongan.

Forty miles further to the Eastward, on a branch of the De Grey, are more gold workings, but owing to the exceptional dryness of last season, very little work has as yet been done. Rich patches of alluvial gold have also been found on the Turner and the Coongan, from which latter, at Shaw's Fall, the celebrated nugget, the "Little Hero," weighing 333oz. 8dwt., was obtained.

Marble Bar.

This took its name from a large mottled bar of quartz which crossed the Shaw River, which was supposed to be marble. There are some exceedingly rich reefs being worked here, many of them being of a very ferruginous character, but all showing gold freely in the stone.

Nullagine.

About 200 miles due East from Roebourne, and 130 miles from the coast, on a branch of the De Grey River called the Nullagine, a considerable extent of alluvial country has been worked, some portions of which have proved very rich. On this field there are, besides the modern wash of the gullies, old gutters or deep leads running through the hills, the wash from some of which will require crushing power before the gold can be extracted. Several rich gold-bearing reefs have also been found, but at present are not being worked, owing, probably, to the expense of getting machinery on to the field.

This is a very rich and extensive field, and it is probable that the alluvial deposits will not be exhausted for some considerable period, and when they are, there will still remain many reefs to fall back upon, which are so rich at the surface that some of the alluvial diggers have been able to make very fair wages by simply dollying the stone during slack periods. Many of these reefs would probably have been worked, before this, had it not been for the expense of transporting the machinery. There is not the least doubt that a good and permanent supply of water exists at no great depth from the surface.

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 in sinking post-holes for a fence. The gold occurred near 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.

THE ASHBURTON GOLDFIELD.

(Proclaimed December, 1890.)

The field embraces an area of 8,200 square miles.

The Ashburton Goldfield is situated on the Ashburton River, and extends from a point 150 miles from its mouth for 150 miles inland. This river, for the most part, flows over large alluvial plains, with low ridges of clay, slate, and quartz outcropping here and there, and flat-topped ranges away to the South; but in one place, called the Gorge, the hills close in upon the river, which flows in a deep rocky channel for a few miles.

Most of the gold workings lie on the Southern side of the river, the only exception being the "Dead Finish." The strange thing about this field is that gold has never yet been found in the reef, although very promising stone is often met with.

Top Camp.

About 15 miles East of the Eastern end of the Capricorn Range gold was first found at a place called the "Top Camp," in some deep creeks on the Southern side of the river Ashburton. The wash was of no great depth, and the gold was highly water-worn and in large flat bar-shaped pieces found in the ledges of the clay slate bottom; the largest of these weighed about six pounds. Over 10,000 ounces have been taken from these workings. No reefs carrying gold have, as yet, been discovered in this locality.

The Soldier's Secret.

Fifteen miles further Westward, down the Ashburton, on the Mt. Blair Creek, at the Eastern extremity of the Capricorn Range, another patch of alluvial works is situated called "The Soldier's Secret." The gold is found here in much smaller pieces than at the "Top Camp," the largest piece having only weighed about an ounce. It is estimated that over 1,500 ounces have been raised.

The country here is rough and broken, with deep creeks running through rocks of clay slate.

Dead Finish.

On the opposite (North) side of the river, about 30 miles further down, is a small patch of workings called the "Dead Finish." Here the country is not nearly so hilly as on the other workings, but many more quartz reefs exist, in which, as yet, the presence of gold has not been detected. These diggings have


INDIAN
OCEAN
DAMPIER'S ARCHIPELAGO
Legendre I.
Gidley I.
Rosemary I.
Enderby I.
Dolphin I.
Depuch I.
Forrestier I.
GEOGRAPHE SHOALS
C. Thouin
COSSACK
ROEBOURNE
Monte Bello I.
Barrow I.
Double I.
Shoal I.
Bessieres I.
Bougle Is.
Mary Anne I.
Direction I.
Muiron I.
N. W. Cape
C. Locker
ONSLOW
EXMOUTH GULF
FORTESCUE R.
HAMERSLEY RA.
ASHBURTON
ASHBURTON GOLDFIELD
Mt. Stuart
Mt. Edith
Mt. De Courcy
Mt. Vigors
Mt. Bruce
Mt. Samson
Mt. Farquhar
Mt. Brockman
Mt. Lionel
Mt. Turner
Mt. Palgrave
Mt. Padbury
Capricorn Ra.
Boring Downs
Pt. Cloates
Anderson Pt.
C. Farquhar
LYNDON R.
MINILYA
Mt. Vernon
Mt. Augustus
Mt. Phillips
Lockier Ra.
Mt. Samuel
Mt. Candolle
Mt. James
Mt. Egerton
Mt. Gascoyne
Walburg Ra.
Mt. Dalgety
PYRAMID
C. Cuvier
GASCOYNE R.
CARNARVON
Bernier I.
Dorre I.
SHARK BAY
DENHAM SOUND
GLADSTONE
Hutchinson I.
Faure I.
Telegraph Station
Byro Plain
Macadam Plains
Mt. Matthew
Mileurah
MURCHISON
MURCHISON G. F.
Yalgoo
Mt. Murchison
Mt. Magnet
Mt. Gould
Mt. Bairn

not proved very rich; only a little over 1,000 ounces of gold have been taken from them; the largest nugget weighed about 8 ounces.

Gold is always to be found on this field, but generally only in small quantities, and it is here that the diggers principally congregate during slack times.

The Gorge.

On the opposite (South) side of the river from the "Dead Finish" a little work has been done in some deep gullies, but although some nice nuggets were found, it was not considered rich enough to support a number of men. These workings are known by the name of "The Gorge." The amount of gold obtained from here is not known, but it is highly probable that it was a fair quantity.

Mount Mortimer.

Seven miles South-East of a hill, marked Mt. Dawson on the map, are situated the Mt. Mortimer diggings; here the country is very different from what it is further up the river, being much flatter, and the clay slates being replaced by more sandy and ferruginous flags. The sinking here, as a rule, is deeper and much more difficult. The largest nugget found is said to have weighed 4½ lbs., but, as a rule, gold is not found in very large pieces, and the fact of its being associated with more ironstone than on the other workings places it at a lower value.

The rocks consist of clay and chloritic slates, sandstones, and quartzites (the slates being often of the cleavable kind used for roofing purposes), and are intersected by numerous quartz and ferruginous lodes.

The auriferous belt of country extends from the junction of the Hardey River with the Ashburton, a little to the North-East of Mt. Clement, following the latter river in a South-East direction for about 150 miles. It is bounded on the South by the Barlee Range and a flat-topped table-land, which follows, at a distance of 14 miles to the South, the main course of the river. To the North it extends across the Ashburton and Hardey Rivers to Mount Wall and Mount de Courcy, a distance in a Northerly direction from the river of from 20 to 30 miles, giving an auriferous area of about 10,000 square miles.

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, as it must be from this direction that the gold was derived, as there is no gold-bearing country to the Southward of the diggings, and the gullies themselves have cut no reefs.

Although nothing is being done on this field, it will, in the future, probably prove to be the richest alluvial field in the colony, as it is the only one where there is any extent of deep ground; but this has not yet been prospected, owing to the great expenses and the small areas allowed for a claim, as this deep-sinking would require more than one man, for which there is no provision made in the regulations.

THE MURCHISON GOLDFIELD.

Proclaimed area, 32,000 square miles.

The principal auriferous belt is situated at the Eastern side of this area, about 200 miles from the coast. It runs in a North and South direction from West Mt. Magnet to Austin's Lake, then in a North-Easterly direction to Lake Anneen and Yagahong. Other rich patches and belts exist further East, and a few patches have also been discovered nearer the coast.

The Government have given Mr. Connelly the reward for reporting the discovery of payable gold on this field, but he had so little faith in his own discovery that he did not stay to prospect it. This was by no means the first discovery of gold on this field, as it was discovered at two places previous to this, viz., Mulga Mulga and Yuin, but in neither case did it prove to be in payable quantities.

The gold-bearing belt runs nearly North and South for a distance of over 100 miles, the different patches being separated by either high sandy table-lands or intrusive granite. The country is mostly open with no main ranges, but it is comparatively high, as it forms the water parting between the Murchison River and the lakes of the interior.

The Nannine.

The main line of reef runs North from the lake up to the spur of a rough ironstone ridge. It stands up in huge blows in places, and would, to anyone used to gold mining in other parts of the world, present a very unpromising appearance. But in spite of the fact that gold rarely occurs near these great blows, patches were found along this reef of great richness, and from holes a few feet in depth small fortunes were taken.

On sinking, these rich patches were lost, as the shoots dip to the North at such a slight angle, when it was supposed that the reef would prove to be barren in depth, but fortunately the sinking was continued to the water level, when the next rich shoot from the South was struck, and in driving at this level to the North-West the first shoots worked were again found. These rich shoots in the main line dip North at an angle of about 30° following the intersection for the most part of the ferruginous jaspery beds; besides these shoots of rich stone, the heavy bunches of rich stone, and the breaks in the reef, all follow the same dip as well as the striations on the walls.

The rocks are mostly schistose with hard bands of ferruginous jaspery quartzite; these strike North and South, dipping at a high angle to the Eastward, whilst the reefs strike a little to the East of North and dip a little to the West where they do not go down vertically.

The main line of reef is well defined for a considerable distance, following a true course with rich patches of gold occurring here and there along it, but at the North end it pinches out, and is lost at the surface, but was again found in depth, as all the rich shoots are dipping this way. To the Southward the main reef begins to split and change in character, losing its very defined appearance; whilst further South it splits and makes again, but nothing of any great value has been found along it here.

This reef, which is mostly white at the surface, is of a bluish colour, and contains a little galena and pyrites in depth, and is altogether of a very promising appearance. It is decidedly a main fissure vein, and the rich shoots will most probably be found to go down for an unlimited depth.

On the Westward side of the Nannine line, in the valley, are a series of reefs more or less on one parallel line with the first-named. They are evidently due to the lateral dislocation which took place when the main fissure was opened. Although following about one line, there is nothing to show that they are one and the same reef; in fact, on the other hand, when attempts to trace them have been made they have always failed. They are in all probability a series, not one reef, and will be found to dip to the Northward, following the same lines as the Nannine.

On the Eastward side of the main line are also some more reefs, but, like those to the Westward, they cannot be traced for any distance; but on all those on which gold has been found the rich stone should be followed.


MURCHISON
GOLDFIELD
YILGARN
G. F.
INDIAN
OCEAN
GERALDTON
NORTHAMPTON
DONGARA
PERTH
FREMANTLE
NEW NORCIA
TOODYAY
NEWCASTLE
NORTHAM
YORK
BEVERLEY
SOUTHN CROSS
CUE
NANNINE
Macadam Plains
Byro Plain
THE ROBINSON RANGES
MIDLAND RAILWAY
J. Forrest
1869
L. Barlee
L. Austin
L. Monger
L. Moore
L. Deborah
L. Seabrook
Mullewa
Mingenew
Rottnest I.

A very rich patch of alluvium workings were on an island to the Southward on this same line, and several other rich patches of surfacing were also found on both sides of the main ridge.

There is plenty of fresh water on this field, and timber within a reasonable distance. The only drawback to the water is that it will in all probability become slightly brackish when heavily drawn upon, particularly towards the end of the summer.

Between Lake Annean and Yagahong the country is flat and is mostly covered by thickets.

Gardner's.

Gardner's find is situated near the Yagahong, a hill about 20 miles East of Lake Annean here; the gold appears to have been quite accidentally found by a party who had lost their way in a thicket. The reef does not out-crop at the surface, and there are no rocks visible, the whole being capped by a white deposit called locally "opaline." This deposit generally consists of either gypsum and sand or magnesia, and is often very hard; it is deposited by the action of water, which is in most cases found in close proximity. This locality, however, proved the exception to the rule.

The stone is brownish and whitish quartz, intermixed with a certain amount of broken country and casing, measuring together about 8ft. in width, which carries a large quantity of fine gold all the way down to the water level, which is 59 feet here. This lode strikes in an East and West direction, dipping nearly vertical, or a little to the Southward. It is of a very different character to any other stone on the field, and although no showy specimens are found the stone is extremely rich, as it carries fine gold all through.

Quin's.

Quin's is about 12 miles South of Yagahong near Nowthanna, the country between the two points being mostly loamy without out-crops of rock.

At Quin's some low rough ranges of metamorphic rock rise from the plain, which, for a considerable distance from them, is strewn with stones.

The reefs here are mostly large and very ferruginous; in fact, in some cases, would be better described as iron lodes. These of course, although consisting of hæmatite at the surface, will make into pyrites in depth, which will be more troublesome to work; therefore, only those reefs which are very rich will be worth working after they cease to pay the prospectors to do so by hand.

Some of the gullies in those hills proved very rich in alluvial gold, and were easily worked, as the gold was found in a defined gutter, but up to the present no reefs along these gullies have been found which were rich enough to work.

About 100 miles North of this, in the Robinson Ranges, on the North side of the Murchison River, two other rich patches of workings were opened, one being called the Horse Shoe Bend. These are probably not on the same line of country as the Murchison proper, as it seems to take a sudden turn to the Eastward at the Nannine and Gardner's.

Between Lake Annean and the Cue, a distance of about 50 miles North, the country is mostly covered by the remains of the tableland formation, portions of which are still left standing on some small hills close to the North side of the Cue. This country is mostly covered with thickets, but it opens out in places into large salt, sandy flats or stony plains around the bases of the one or two ridges of metamorphic rock which outcrop here and there between the two points. There is also a large patch of limestone country near the Milley Spring, at which place there is a nice little forest of white gum and morrell, which latter timber is of great value for mining purposes.

The Cue.

At the Cue itself the largest patch of auriferous country exists that has yet been found on this field; it was quickly skimmed over, as no gold was found by sinking, but all on the surface. Here are situated the celebrated "specking" grounds, over which hundreds of men walked day after day, turning over every stone with a forked stick to see if it might not be a specimen or cover a nugget. A very large quantity of gold was found in this way, and a stray piece is now and then still picked up.

The surface of most of these patches is covered with quartz and ironstone, and a good deal of the quartz carries a little gold. Many of these patches, after being specked, paid to be dry-blown, but in other cases all the gold was either found as specimens, or in too large pieces to be missed by the speckers, and therefore is of no value to work afterwards.

There are three distinct classes of reefs about here; the first is the Lady Kintore line, which rises abruptly from the plains, forming a main ridge on the South-West side of the Cue Hill; this reef is composed for the most part of a white, barren-looking quartz, and its course is not in one defined direction, but turns away to the Eastward at the Northern end.

The rocks about here are mostly of a schistose nature, with numerous diorite dykes; but more to the Westward the country consists entirely of a white, decomposed granite, in which the second class of reef is met with. These are of a white, glassy, hungry-looking quartz, with many cavities, which are usually filled with crystals of green foliated talc and crystalline gold. Part of the lode is a decomposed green magnesian rock, which also carries gold.

These reefs are well defined, and have every appearance, as they are opened up, of being true, permanent veins; but they are different to anything that has been found before.

The other class of reef is of a blue colour. These lie to the North-East of the Cue, but have not been developed enough yet to form any opinion about them.

This line of gold-bearing country runs in a continuous line in a North-Easterly direction to the "Four Mile," which derives its name from its distance from the Cue. Here a line of reef rises up abruptly, forming the main ridge, the general characteristics of which are very similar to the Kimberley reefs.

This line is called the Day Dawn, after the first claim taken up on it. The stone is of a bluish mottled appearance, and the reef is of great size and well formed. It is a true fissure vein, but does not follow any definite course, striking first West-North-West, then North-North-West, and so on to North; but this is not of the least consequence, as, from its well-defined walls, there is very little chance of it cutting out.

Some very rich patches of surfacing were found on the sides of this and several other reefs about here and all the way in a North-Easterly direction to the Cue proper.

Another patch on this line is called the "Eight Mile," being about that distance from the Cue. Here several very promising and well-defined reefs were found on a flat, and on the East side of a low ridge of metamorphic rock, where the same jaspery ironstone is met with; but as yet so little has been done to open up the country that it is quite impossible to say anything about the formation of these lodes.

The Dead Finish, or Cuddingwarra.

About 7 miles due W.N.W. of Cue townsite another patch of Metamorphic rocks outcrop, where several gold-bearing reefs were found, a small but rich patch of alluvium worked.

Mulga Mulga or Bieren.

A few miles North of Cuddingwarra, gold was discovered in the year 1888 by a man named Birk, but for some reason very little prospecting was done, or the rich patches of the Cue would have been found sooner.

The reef is small and not well defined, but shows fine gold in places in the stone at the surface, associated with a little copper pyrites, iron pyrites, and antimony.

The Nancarrong Hills.

About 150 miles to the South-Eastward of the Cue are the Nancarrong Hills, where, in the early part of 1890, gold was discovered in a reef on a low range of hills, about five miles to the Eastward of Yuin station.

It is a large reef of bluish glassy quartz, with copper stains, striking East and West, and apparently dipping to the North, but going down nearly vertical as far as can be judged. The rocks, which are quartzite and mica slate with granite dykes and ironstone lodes, follow the same strike as the reefs.

There is plenty of good water, and from its nearness to the coast, much poorer stone will pay well here than at the other side of the field.

Between the Cue and Austin's Lake, after leaving the "Eight Mile," the country for 10 miles South-East is covered by thickets for the greater part of the way, but upon approaching the lake it opens out into large salt, sandy, and clay flats covered with samphire.

The Island, Austin's Lake.

The island is a high ridge of metamorphic rock, the main axis of which is a bed of ferruginous jaspery quartz (ironstone). It runs in a nearly North and South direction for a distance of about two miles, being divided from the North and South shores by two narrow arms of the lake, each about half-a-mile wide, which are quite impassable after heavy rains. This, added to the fact that there is no fresh water on the island, renders it anything but a pleasant place to get weather-bound in.

The diggings on the island were some of the richest and most concentrated on the field, and it is the only place where anything like deep ground was met with, a defined gutter being found on the bed rock at 15 feet from the surface.

The alluvial ground ran down from a saddle near the centre of the island, in an Easterly and Westerly direction, towards the lake, but no auriferous reefs have yet been found immediately on its course. The sinking was pretty tough in places, as the alluvium was cemented together by gypsum.

The reefs are phenomenally rich, but do not seem to carry gold for any great distance along their outcrop. The one on the main island runs in an East and West direction, cutting a main North and South reef at its intersection, with which some very rich stone was found. The other is on a small island to the North-East, and was also excessively rich, but in this case the main reef carried the gold at its junction with two leaders, one of which strikes to the North-East, and one to the South-East.

Other reefs should be prospected for upon the saddle at the head of the leads, for the very heavy gold found there has not been carried far. As on the other parts of the field the richest shoots in the reefs were found where they crossed the ironstone bars; this should be borne in mind in prospecting for reefs here.

Other rich patches of diggings exist on the main land to the North side of the lake, and a patch of country well worth prospecting lies to the Eastward from it.

Between Lake Austin and Mount Magnet, where the next rich patch of diggings are situated, the country does not present such an auriferous appearance, as most of the rocks are intrusive granite, often overlaid by desert sandstone, but there are one or two small patches of promising country.

The distance between these two points is about 35 miles by road; but this might be considerably reduced if a proper road were cut.

Mount Magnet.

The Mt. Magnet diggings are situated a few miles to the South and West of West Mt. Magnet, which hill is principally composed of Metamorphic rocks, capped by a flat top of desert sandstone.

The rocks strike mostly a little West of North, dipping to the Westward; they are slate, dolomite, talcose schist, and ferruginous jaspery quartzite, all of which are very decomposed.

The reefs follow much the same strike as the rocks, and dip also to the Westward. They are small but well-defined, and in some places appear to carry gold pretty well through the stone. The quartz is mostly white and rather greasy, with ferruginous stains and yellow clay partings, but nothing very rich has been found in the reefing line on this part of the field except a large mullocky mass, which is not a true reef, but a mass of decomposed talchose schist through which there are a number of small ferruginous quartz veins, the whole mass carrying fine gold. On the surface here a small but very rich patch of alluvium was worked all along the side of a large ferruginous quartzite bar.

All the alluvial work here has been surfacing, these patches being worked, where a mixture of quartz and ironstone was found scattered over the surface.

The auriferous nature of this patch of country has apparently a certain connection with a large ferruginous dyke which lies close to the Westward of the workings, and which does not follow the exact strike of the country. A very great deal of gold has been obtained from this claim by simply puddling and washing the decomposed rock, whilst the stone has been reserved for crushing. This seems to be an extremely rich deposit, and the gold will probably be found to go down associated with iron pyrites, and should pay very well, considering the richness and quantity of the gold-bearing stone and the ease with which it can be worked.

On this field, as a rule, the rich patches are met with at the intersections of the quartz reefs, with the ferruginous bars or with other quartz reefs, but gold has also been found in ferruginous calcite, and in barren-looking white quartz in granite country.

There is a great variety of stone on this field, and the reefs are of two or three totally different classes, but as they are, as a rule, rich, and do not seem to be troubled with faults, there should be no difficulty in working them.

Water.

The field, as a whole, is well watered, and, as a rule, the water is good, the only exception being near the Salt Lakes; but even there, if a well is sunk a short distance away, the water is found to be fresh.

At the island in Austin's Lake there is nothing but salt water, and at Cue even inferior water was not obtainable nearer the surface than 100 feet.

In most of the mines good water has been struck at considerably under 100 feet, and if a supply is to be found at all, it will be found along these lines of fissure.

There is no immediate prospect of the water question standing in the way of the development of this field, as it has of so many others in this Colony; but the timber question will be far more serious, particularly at the South end of the field, where there is nothing but mulgar.

Extent.

The gold-bearing belt, as far as at present worked, extends in a North and South direction for a distance of about 100 miles, but it will probably be found to extend in patches all the way South by Boodano and Mt. Kenneth to the Yilgarn Goldfield, as it is on the same belt which runs South to the Mt. Barren Range on the South coast.

To the North-West it is either suddenly cut off or thrown to the Eastward by the change in the strike of the country, which here runs North-East and East; the rocks, too, lose their auriferous character, being replaced by hard crystalline and granite rocks.

It is highly probable that this belt will be found to run in the direction of Windich Springs, but it is difficult to trace owing to the auriferous rock being mostly covered by the desert sandstone formation.

To the Eastward rich patches of auriferous country seem to be met with wherever the more modern formation has been removed; and from Sir John Forrest's description of the country there is every probability of gold being found all the way to the South Australian boundary along the lines of depression where the old rocks outcrop.

To the Westward there is little prospect of the field extending, as it lies immediately to the Eastward of the main belt of intrusive granite, which is about 100 miles wide, in which, however, there are one or two little patches of likely-looking country. On the Western side of this belt, at Yuin, gold has also been found, but this is on the same line of country as Kendinup, the Darling Range, Bindoon, the Wongan Hills, and Peterwangy, and although it may be a very nice little patch, an extent of rich gold-bearing country is not likely to be discovered,

THE DUNDAS GOLDFIELD.

Gold was discovered some years ago on this field by Mr. Moir, but it was not till 1892, when Messrs. Mawson and Kirkpatrick discovered a rich gold-bearing reef, that this belt district attracted any attention.

The belt is narrow, and seems to be the Southern extension of the Coolgardie line, but South of this it has not been traced.

There are three or four lines of gold-bearing reefs, but the gold-bearing stone rarely outcrops, so that a good deal of prospecting is necessary.

The reefs that have up to the present been opened up are well defined and rich, having all the character of true lodes. They strike North and South, dipping to the West at a high angle. There will be abundance of water when shafts are put down, and there is any quantity of timber on the spot; this, considered with its proximity to the South coast, which is a little more than 100 miles, and the good rainfall, should greatly facilitate the working of these reefs.

No alluvial gold has yet been found here, and there does not seem much prospect, as the gold-bearing reefs have not been denuded.

THE EASTERN DISTRICTS.

At York, from time to time, gold finds are reported, but these have never yet proved of any value, but there is not the slightest doubt that a gold-bearing belt does run from the Wongan Hills. South, by York, along the Great Southern Railway to Kendinup, there is not the least doubt but the gold will be associated with pyrites as in the Darling Range.

THE INTERIOR.

As far as prospectors have travelled inland along the broken lake country they have found gold often in very rich deposits, but have, up to the present, been prevented from working them owing to the want of water; but as wells are sunk on the existing fields the workings extend gradually further Eastward, and there is very little doubt that this class of country will extend in belts to the South Australian boundary.

RETURN OF THE GOLD EXPORT FOR THE LAST SEVEN YEARS.

Year.	Ounces.	Value.	At per oz.
		£	£ s. d.
1886 ...	...	1,207	...
1887 ...	4,873	19,492	4 0 0
1888 ...	3,493	13,098	3 15 0
1889 ...	15,492½	58,871	3 16 0
1890 ...	22,806	86,664	3 16 0
1891 ...	30,311	115,182	3 16 0
1892 ...	59,548	226,283	3 16 0
1893 ...	110,891	421,385	3 16 0
Total ...	247,414½	952,182	...

This return is the amount declared at the Customs, and is far below the actual export.

OTHER MINERAL DEPOSITS.

COPPER AND LEAD MINES OF THE VICTORIA DISTRICT.

In this district the copper and lead occur associated together in the same lodes, with sometimes blende, ferruginous graphite, barytes, and quartz.

The lodes, which have a course more or less North and South, make their appearance here and there, where the overlying Mesozoic rocks have been removed, in a raised belt of country, about 60 miles long, stretching from the Geraldine Mine, on the Murchison River, in the North, almost to Geraldton, in the South. They consist of very large and rich deposits of lead and copper, which were successfully worked for many years; but owing to the great fall in the price of these metals, and the very small percentage of silver contained in the lead ore, work has been almost entirely suspended, and at present only sufficient ore is raised to supply ballast to the wool ships.

The lead is found in the form of carbonate (*cerussite*) and sulphide (*galena*) of great purity, and the lodes, which are of immense width, contain so little gangue mixed with the ore that the galena can be dressed, with very little labour, up to 83 or 84 per cent.

The copper ores are also very rich, consisting near the surface of blue and green carbonates (*azurite* and *malachite*), with ferruginous oxides and a certain amount of native copper, whilst below the water level the lodes are almost entirely composed of sulphides (*copper pyrites, copper glance,* and *covellite*); these might

MURCHISON RIVER
Pencell P.
Geraldine Mine
Telegraph Line
Ajana Well
Appatarra W
Baker's W
Desert W
Minnoo Sp
Mongeragarry Sp
Wollyllia
Woottarina
Mandalow Sp
Monderwerrino Sp
Chiloming Sp
Mumbywerino W
MT VICTORIA
MT ALBERT
KIANOOKA HILL
MT WILLOUGHBY
LYNTON
Appadagenna Sp
APPADAGENNA PEAKS
Jib Jib W
JIB JIB HILL
MT GREGORY
Martins Sp
Weeine W
Arina W
WATHALA SW
NONGA H.
Nonga Sp
Yanganooka Mine
White cliffs
Woombearrow W
Beetanenec
Udandarra
GRANITE H.
Wanerenooka Mine
Wooleah
Wheal Fortune Mine.
NORTHAMPTON
Allen Nolla
WHALEBOAT COVE
Nokanena
Gwalla Mine
Marra W
Naralying
BOWES RIVER
Wooderaccah W
Washenborough W
WATERLOO RA
MOOLYMOONGA
KINGS TABLE HILL
BROWN HILL
BALLATARRA
Waterloo W
INDIAN
FOSSIL HILL
Paradise W
Erin W
TABLE HILL
Nabawa Pool
Woolawar Gully
MT SEWELL
THE FALSE MAN
MT ERIN
Indiala Sp
Narra Tarra Mine
Yangaro Sp
Yellow Gully
Howatharra W
CHEELVINK
Beretheno Sp
Durawah Sp
Oakajee Mine
NIGHTCAP H. (ETAH)
OAKAJEE RIVER
Oakajee Sp
Celira Mine
GNOWS NEST
5 MILE H.
6 Mile W
G.L.
CHANNEL
BULLER RIVER
WOKATHERRA H.
Spring W
Noonans W
WHITE PEAK
MUMBEMARRA
YANGET H.
Miarra W
SMUGGLERS COVE
RED PEAK
Yanget Sp
OCEAN
BEATENALLY
CHAPMAN RIVER
Narra Tarra
THE BROTHERS
CHAMPION BAY
Woodherina Sps
Tibradden
MT FAIRFAX
GERALDTON
JETTY
Durawarra
TIBRADDON H.
Pt Moore
Lighthouse
Moonyoonooka
Normans W
Mound Sp W
WIZARD PEAK
Minnenooka
PORT GREY

certainly be worked again, now that the price of copper has risen and labour-saving appliances brought to such a stage of perfection.

When the lead mines were at work there were several smelting works in the Northampton District, but these had to stop when the mines suspended operations. The Government, in order to revive this industry, offered a premium of £10,000 for the first 10,000 tons of metallic lead produced, which, together with the fact that a direct line of steamers had been started, calling at Geraldton on the way to Singapore, in which place a good market is found for this metal for China (where even the small percentage of silver it contains is turned to account), tempted a company to put up a water-jacket furnace, but, through insufficient capital being subscribed, the company had to make an attempt with imperfect furnaces and machinery, and short-handed management, which resulted in failure. If properly carried out it should have been a success, with such clean ore in almost unlimited quantity, and fluxes such as ironstone and limestone on the spot.

Since the year 1845, when almost the first shipment of ore from this district was made, 8,529 tons of copper, and 34,055 tons of lead ore, have been exported from this part of the Colony. Of the lead ore, over 23,000 tons were exported between the years 1874 and 1883, the largest amount exported in one year being 3,955 tons in 1877, when it was valued at £12 per ton; in 1880 it fell to £8 per ton, since which date the export has rapidly decreased, as in 1893 no lead or copper ore was exported.

Irwin Mines.

At a little later period copper and lead were found further South in a line of country between Arino Springs and the Irwin River; of these only the copper lodes were worked. On one claim a good deal of work was done, but the lode, though very promising at the surface, was never cut in depth, which was probably due to bad management, as all the lodes are so well defined at the surface that there is no reason why they should be lost at a depth of 80 feet. On others little more has been done than quarrying a few tons to send away, but as the lodes occur 40 miles from the port of Dongara, and the road lies for the most part over heavy sand plains, they were very expensive to work; but now that there is a railway passing close to these mines, and as the lodes are both large and rich, they should again be opened out, and, if smelting works be also started, they should both pay well.

COPPER MINES IN THE NORTH-WEST.

Whim Well Copper Mine.

When it is stated that this mine was worked by about four men for a month or two in 1890, and that from the results the syndicate were able to pay all the working and preliminary expenses, some idea can be gained of the richness, size, and quality of the 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 East and West 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 12 feet in thickness where it has been opened, 6 feet of which can be dressed without the slightest trouble to 30 per cent., and with care even to 40 per cent., whilst the other 6 feet can be dressed to 20 per cent. with a little trouble, and 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 6 feet 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), the 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.

Some copper mines were worked a few years ago a few miles South of Roebourne. 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 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 lately discontinued owing to the low price of copper, but as the ore at the surface is very fair, and the lodes are large and near a port, they could be worked cheaply; and now that copper is realising a higher price they might certainly 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 ferrginous copper lodes occur all over this district, some of which carry from 30 to 40 per cent. of the metal, but the mass of the lode stuff is iron. In some of the specimens gold is plainly visible, and, judging from the assays, would be well worth working. The galenas and cupriferous gossans of this district are also well worth testing.

Exported 1891	...	...	262 tons
Do. 1892	...	...	412 tons
Do. 1893	...	...	50 tons
Total	...	...	724 tons

Kimberley.

In the Kimberley District, copper and lead ores are associated with gold, but only in small quantities. The gold is in a free state, and in the rich specimens is plainly visible to the naked eye.

Some very fine copper ores exist in this district, but the present expense of carriage is too heavy for them to pay.

Mt. Barren.

Near Middle Mt. Barren a copper mine was started, and a good deal of work done on a lode, but hard coast ranges are not of a highly promising character for valuable minerals.

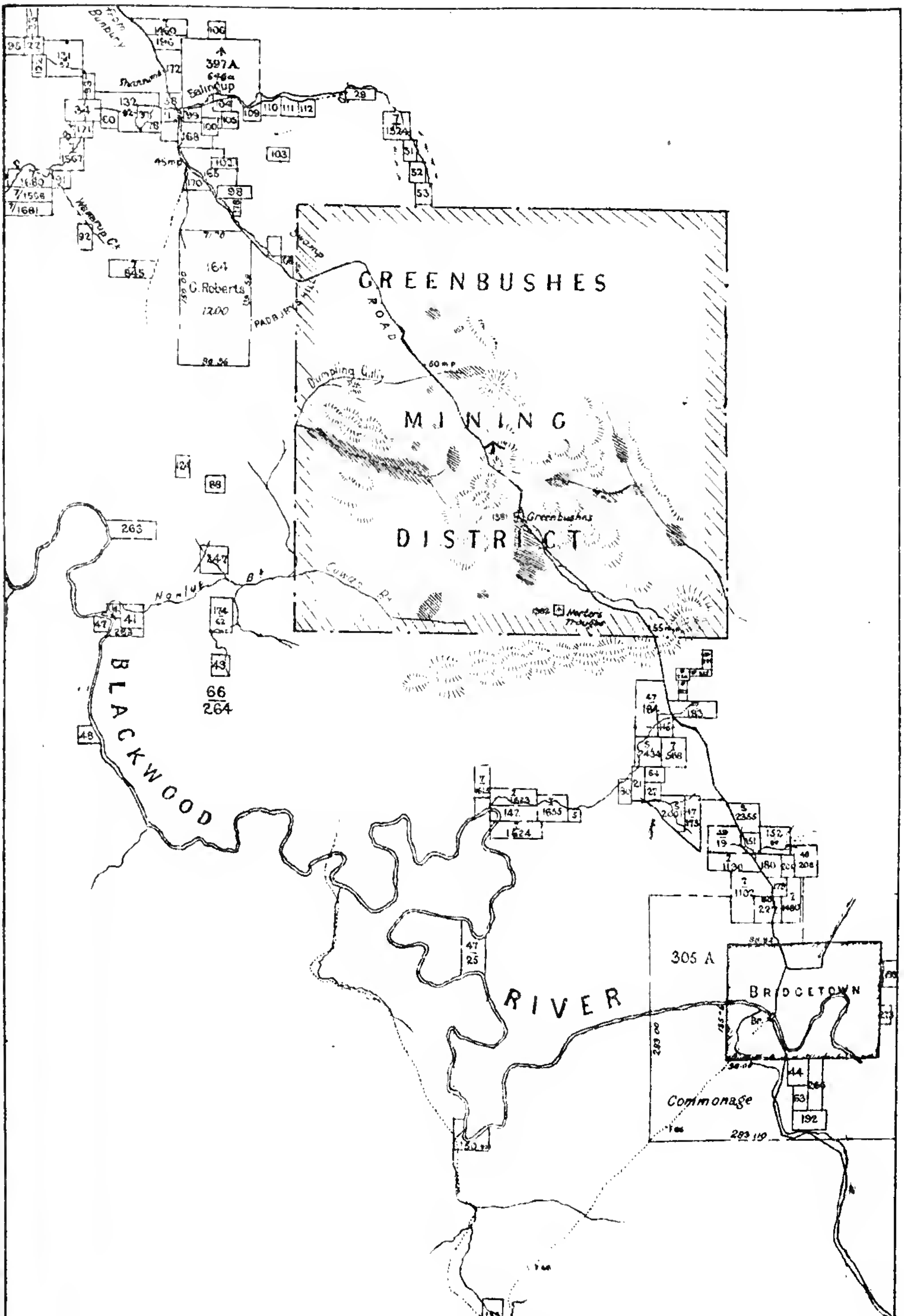
Copper occurs in the Wongan Hills, the Darling Range, the Glenelg Range, as well as in several other places.

TIN.

The Greenbushes Tinfield.

Area, 50 Square Miles.

In the latter part of the year 1888, Mr. Stinton, whilst kangaroo hunting, found a small quantity of stream tin in a gully near the Blackwood River, not far from the main road, about nine miles from Bridgetown and 53 from Bunbury. A large number of leases were at once taken up, but as the old regulations did not contain any labour clauses, very little work was done.


GREENBUSHES
MINING
DISTRICT
ROAD
BLACKWOOD
RIVER
BRIDGETOWN
305 A
Commonage
Greenbushes
Dumpling Gully
C. Roberts
from Bunbury
397 A
Balingup

The field is situated near the highest part of the range, on the North-East side of the Blackwood River, and between two of its branches. From the high peak in the middle of the field the leads and gutters radiate, but as a rule they are better formed on the Southern and Western sides.

Although there is very little surface water on the 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 is at present believed. There is a good rainfall here (36 inches), which, falling on the sandy land, is held for a long time, only gradually sinking away into the solid rocks below, and if the trees were killed, the water supply would be considerably increased. The deepest shafts sunk on high ground have always struck water at from 50ft. to 70ft. During the greater part of the year the want of water is the great obstacle in the way of working, but if properly worked, dirt should be raised during the dry season, and washed during the wet.

The formation of the district is crystalline schist, gneissic, and granite rock, with numerous rocks of diorite, granite, and veins of tourmaline, the surface being mostly covered with nodular claystones (gravel), sand, and ferruginous sandstones, the ferruginous sandstones 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.

The tin wash of the fields varies greatly in thickness, richness, and quantity, running from 3oz. to 15lbs. to the dish, and in thickness from 6 inches to 20 feet; the low percentage washes being in larger quantities, and as a rule much freer than those of the higher percentage. Most of the areas are now worked on the tribute system, the dirt being stacked during the summer, and washed in the winter. The whole of the surface of this field is covered with a modern formation, beneath which the leads run, so considerable prospecting will be necessary to trace them. No lodes have yet been found, but, from the crystalline and unwater-worn character of the tin, they must exist. These will probably be in the form of *stock-works*, a name given in many of the continental mines to a network of thin veins or strings of crystals interlacing through a decomposed granitic dyke, the whole mass of which is usually worked. The field is as yet only in its infancy, and is comparatively undeveloped, but will probably, when more leads are opened up, support a large mining population, especially if worked in claims, as it is undoubtedly what is called "a poor man's field." At the present time only a few areas are being worked, and in the year 1893 only 171¾ tons of tin ore were exported.

The nearest port is Bunbury, from which a railway runs 18 miles to the foot of the range, when a good, but hilly, road connects it with the field. The field has telegraph communication, and a mail coach calls twice a week.

Areas on this field should be worked by their owners, as companies will never pay unless worked on a very large scale, but there is a handsome thing for any-one who will work his own claim. This is proved beyond a doubt by all the companies closing up whilst private individuals are doing well, even when they have to pay a large tribute to the lessee of the area. The best tin occurs along the line of decomposed granite, which line seems 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 extended it is impossible to say until the surface gravel is removed. The tin, as before mentioned, is probably derived from networks and strings of small leaders interlacing through a mass of decomposed granite rock. One patch of these leaders must exist near Mr. J. Austin's claim. The field will provide work for some years, and when the veins from which the stream tin is derived are found, will probably become an important mining centre.

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.

Tin in the North-West.

Tin has also been found in the alluvial workings at Pilbarra, but could not be worked for some time, as the Mining Regulations for working gold and tin clash, and no larger area than an alluvial digger's area could be granted on a goldfield, A very rich deposit of coarse stream tin occurs near Mr. G. and 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, very favourable for deposits of tin.

COAL.

The Irwin Coalfield.

In the year 1846 Gregory discovered some coal seams in the bed of the North branch of the Irwin River, which were shortly afterwards reported on by Dr. Von Sommer, who stated that there were two seams, 6 and 8 feet thick respectively, and a reserve of 10,000 acres was declared, but nothing further was done for many years until at last the Government decided to send the Rev. C. G. Nicolay to report on the value of these seams. That gentleman found that there was so much water to contend with in sinking, and that the coal raised was of such a poor quality, that the field was again abandoned till the year 1888, when Messrs. Bell and Eliot found in the bed of another branch some better specimens. These they traced up to their source, which they found to be a seam in the cliff 4ft. thick and dipping towards the North; into this they drove a distance of 150ft., but it did not prove of sufficiently good quality to induce further work. There are also six other seams of smutty coal; a portion of one of these proved to be of a better quality and ten tons were raised, but, owing to a division in the company, nothing more was done. Several seams have also been opened up on Gregory's branch, but none have at present been shown to be of any commercial value. All the upper tributaries of this river pass through carboniferous shales and limestones, containing lower carboniferous fossils, and some poor coal seams.

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

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

	No. 1	No. 2
Water	17·04	12·4
Volatile matter	28·61	32·2
Fixed carbon ...	41·29	43·5
Ash	13·06	11·9
	100	100
Sulphur		0·83

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

Professor Etheridge reports on a sample submitted to him:—"It is a dull, soft, impure, sooty coal, ignites quickly, and burns to a fine ash, giving out great heat. This example, although impure, is not a lignite. It resembles 'Mother coal,' bands of which often occur in the coal measure seams, interbedded between thick coals of the best quality. It appears to me to have been taken from near the outcrop, or at a little depth from the air. No woody, earthy or sedimentary matter occurs in this sample, and although far less valuable than Nos. 1 and 2, yet it is quite equal to much of the coal used on the North German Railways, and is (although inferior) a true coal-measure coal and not a lignite. No evidence of ligneous structure could be observed under the microscope."

The fossils are all characteristic carboniferous, and although there are no coal-measure plants, there is no reason to doubt that the coal seams and associated limestone belong to one and the same age, *i.e.*, Carboniferous.

The Midland Railway Company have now put down several deep bores without striking any seams of commercial value, but as in no instance have they encountered the metamorphic rocks, this area still remains as much untested as ever.

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 at the head of the DeGrey. It is true that up to the present only carbonaceous shales have been found, and the fossils 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 dip under the Mesozoic formation to the Westward, it is highly probable that true coal measures do exist.

Kimberley.

It is also highly probable that coal will be found in the Northern portion of the Kimberley District, near Wyndham, where the Carboniferous rocks are largely developed; quartzite and sandstone capped flat-topped hills, with shale beds beneath, attaining an elevation of as much as 1,000 feet.

These shale beds must be of great thickness, for in the well at the base of the Bastion Hill they were found to go down over 100 feet, whilst they are seen in sections in the side of the hill 700 or 800 feet. It therefore follows that the only way to make certain whether coal beds do exist is by boring, which at the same time would probably secure a water supply for the town.

The Fitzgerald and Phillips River Coal.

About the year 1846 Capt. Roe, then Surveyor General, and Mr. Gregory, Assistant Surveyor, reported the discovery of coal in the bed of the Fitzgerald and Phillips Rivers, on the South coast, about 100 to 150 miles East of Albany, but it unfortunately proved to be a poor brown coal.

These deposits of coaly matter occur in a series of pockets or hollows resting on the upturned edges of the altered slates and quartz reefs, and are often full of angular fragments of quartz. It will not burn by itself, but, if put into a large fire, smokes and gives off a strong smell of asphalt, and is finally reduced to a firm, bulky ash, of a reddish colour. It is not a true coal, and will never be of any commercial value as a fuel. Both Mr. H. L. Y. Brown, F.G.S., Government Geologist of South Australia, and the Rev. C. G. Nicolay, who visited this locality, report that no carboniferous formation exists here.

Albany Coal.

Some brown coals, of poor quality, have been found all along the South coast, and recently in a bore at Eastwood, near Albany, a three-foot seam was struck, much resembling some of the top beds of the true coal measures.

Fly Brook Coal.

The Fly Brook is the furthest branch, to the South-East, of the Donnelly River, which discharges itself into the Southern Ocean about thirty miles East of Cape Leeuwin. The river is always running, as there is a large rainfall, but, unfortunately, it is not navigable, the estuary at its mouth being closed by a sand-bar. The nearest ports that ships could use are Augusta and Hamlin Harbour, about 30 miles to the Westward.

On this Brook some coal mining leases were taken up in the year 1888, but the existence of these seams appears to have been known for many years to some of the older inhabitants. Several reports had been made which show that four seams of a good coal outcrop in the gully. These were tested in a systematic manner by putting down a series of bores to determine the number, size, quality, and extent of the seams, which were shown to extend over the whole area taken up, the large seams being easily identified when met with in the different bores by their persistent thickness, associated beds, and partings; but, up to the present, the entire thickness of this formation in the deep ground could not be tested, as there was so much water in drifts that the bore hole was continually falling in. One of the bores passed through about 20ft. of coal in sinking to a depth of 128ft. This consists of 17 seams, the largest being 5ft. 4in. with a 6in. clay parting, 2ft. 4in. with a 3in. parting, and 2ft. 3in. with a 2in. parting. Other seams, up to a foot in thickness, could also be worked, as several occur close together separated only by shaly partings.

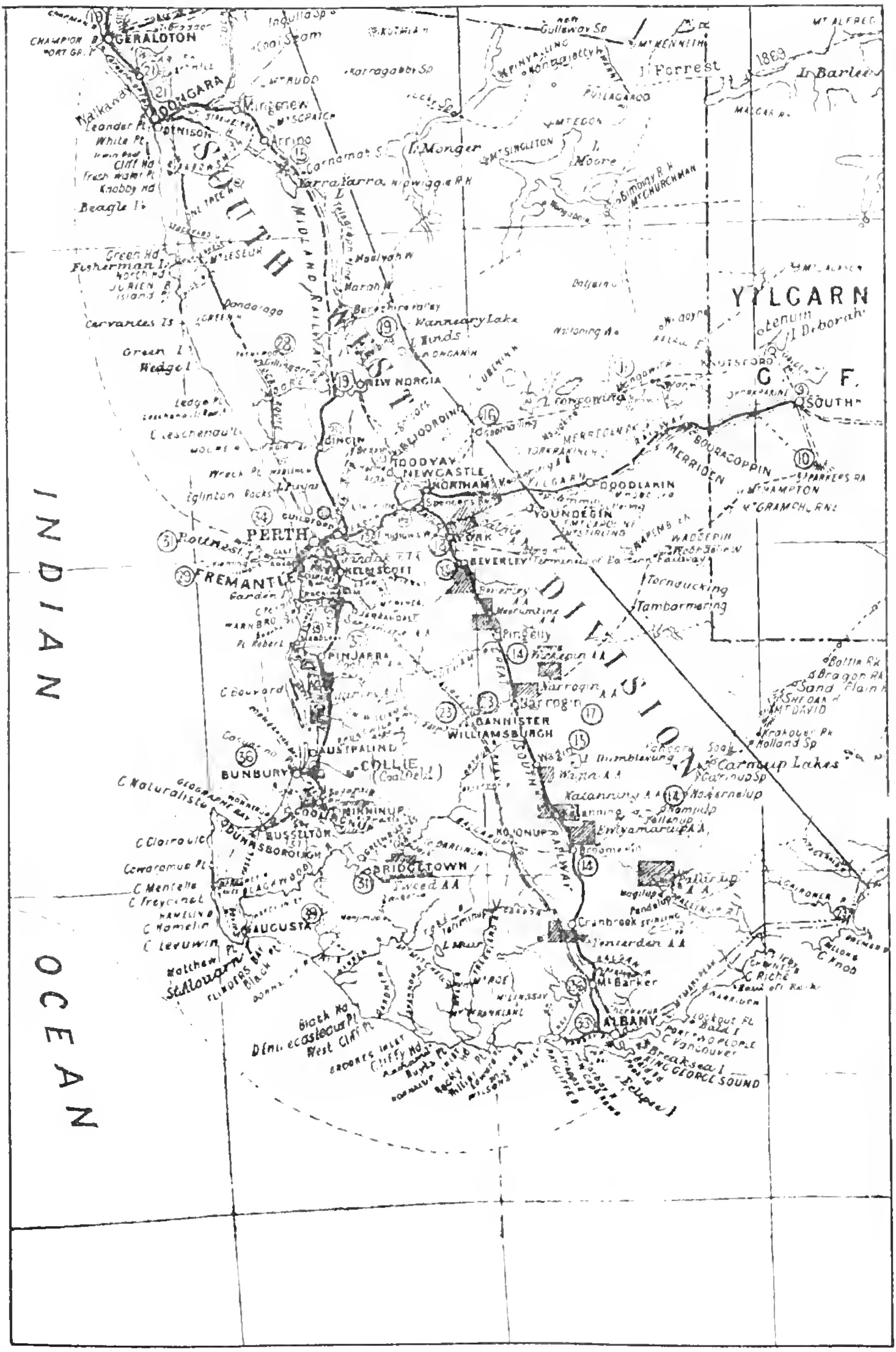
The coal itself is a highly lustrous variety, having almost the appearance of jet, but lacking its hardness, while the woody structure is clearly visible in some pieces, and on assaying it proved to be almost identical in composition with the coals of the Pacific coast of North America.

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

	Fly Brook.
Water	16·40
Volatile Matter	38·23
Fixed Carbon	43·52
Ash	1·85

As the similar coal in America is used largely for steam and other purposes, there is no reason why this should not turn out to be of great value to the Colony, the great drawback being the distance from a port and the large percentage of water it contains, which renders it too friable for much handling. It may be said that the samples sent away were no test, as they came out of the creek bed; but this will not make the slightest difference, as the superfluous water would have had plenty of time to evaporate before it reached the assayers' hands, and the coal from a depth will be found to contain nearly as much.

The coal-bearing series here consist of sandstone, grits, and clay beds (the latter of which are often micaceous), the whole being overlaid by a bed of ferruginous conglomerate, containing large water-worn pebbles of quartzite, quartz, and other crystalline rocks. This bed is met in many places in the district, and probably forms the junction between the series and the more recent clays, sands, and ironstone which covers most of the surface. From information gathered, it may be concluded that this formation will be found to extend over a considerable area, at first in a North-Westerly and then in a Northerly direction, towards the Vasse, where some samples of a less highly mineralised form of coal have lately been found in sinking a well.



GERALDTON
DONGARA
Mingenew
Arrino
SOUTH WEST DIVISION
MIDLAND RAILWAY
Carnamah
Yarra Yarra
L. Monger
J. Forrest
L. Barlee
L. Moore
YILGARN
G. F.
SOUTHN
Bencubbin
NEW NORCIA
GINGIN
TOODYAY
NEWCASTLE
NORTHAM
YORK
BEVERLEY
PERTH
FREMANTLE
Rottnest I.
Garden I.
PINJARRA
C. Bouvard
Pingelly
Narrogin
WILLIAMSBURGH
BANNISTER
AUSTRALIND
COLLIE
(Coalfield)
BUNBURY
C. Naturaliste
Geographe Bay
BUSSELTON
DUNNSBOROUGH
BRIDGETOWN
Tweed A.A.
AUGUSTA
C. Leeuwin
C. Hamelin
C. Freycinet
C. Mentelle
St. Alouarn
Flinders Bay
Wagin
Katanning
Broomehill
Cranbrook
Tenterden
Mt. Barker
ALBANY
King George Sound
C. Riche
Carnarvon Lakes
Bourancoppin
Merriden
Doodlakin
Youndegin
Fisherman I.
Green Hd.
Jurien B.
Cervantes Is.
Green I.
Wedge I.
Beagle Is.
Leander Pt.
White Pt.
Cliff Hd.
Knobby Hd.
Champion B.
Eglinton Rocks
Wannearny Lake
Beverley A.A.
Kojonup
Dumbleyung
Tambarmering
INDIAN
OCEAN

THE COLLIE RIVER COALFIELD.

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, and 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 waterhole, 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 hundredweight or so was raised.

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 hard crystalline schists and granite.

From this gorge it emerges on the plain 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 Estuary, about 5 miles to the North-East of Bunbury, which town is situated at the mouth of this estuary.

The Situation of the Coal Seam.

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 claystones (gravel).

The second seam is situated about five miles higher up the river, to the Eastward, or between 25 and 30 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 degrees to the Westward, proving that the greater elevation has taken place to the Eastward in this district since the deposition of these beds.

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, 13 feet 7 inches of coal is said to have been sunk through, but further prospecting was stopped by the large quantities of water which made in the shaft.

Another shaft has been sunk further from the river to a depth of 35 feet through sandstone and shale. From this point a bore was put down, which proved the seam to be about 18 feet in thickness, and that several other small seams existed below it, some of which would be large enough to work.

This seam has now been traced by means of bores in an East-South-East direction for a distance of about two miles, generally proving to be from 10 to 12 feet in thickness, but it will probably be found to be of greater size further into the basin.

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, but it is non-caking.

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 draught, but will burn slowly until all is consumed, leaving a bulky ash if the draught is cut off. It forms no clinkers or slag, gives off little smoke, and the percentage of ash is small; so that it should be a very suitable coal for furnace purposes.

Assay.

Volatile	Water	15·20	10·87	11·70	12·75
	Gases, etc.	32·46	31·47	21·83	37·04
	Sulphur	2·23	2·23	2·99	0·71
Coke	Fixed Carbon ...	45·08	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 17 feet, close by No. 4, from an intermediate depth, the same being three feet thick; No. 3 from a shaft five miles further East.

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

Geological Age.

Professor Etheridge reports as follows on two samples:—

No. 1.—This I believe to be a good and true palæozoic coal; it is bright, dense, evenly-bedded, and bituminous. This sample is equal to the better class of coals of South Wales and the North of England. Portions of *Glossopteris*, or *Nœggerathia*, occur in this coal. This is interesting, as both these genera are abundantly represented and very characteristic of the coal of Newcastle, New South Wales; so that we are probably dealing with a coal from the same horizon (geologically) and marked by the same flora.

"The highly carbonized condition of this sample, I doubt not, characterises the general condition of the seam from which it was taken. It burns slowly, but with considerable heat, leaving little ash.

"No woody or *ligneous* structure could be detected, and there is no resemblance to any coal of that type. No spores could be detected under the microscope.

"No. 2.—This sample closely resembles No. 1, but it is hardly so strong or firm a coal, though, apparently, as highly carbonised. The difference is, however, so small that I should have been inclined to believe that both samples came from part of the same seam, merely exhibiting those minor differences of density and quality only ascertained under combustion. Both these samples consume slowly, with but little smoke. They are both sound coals, and doubtless of palæozoic age."

Associated Rocks.

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

Extent.

This belt of country appears to run in an East and South-East direction at the back, or to the Eastward of the Darling Range, but it does not extend far towards the North. 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 rocks, through which this river has cut its channel.

Means of Export.

The nearest port is Bunbury. The road is very good for 15 miles to the Collie Bridge, after which it has to cross the high rough Darling (about 1,000 feet), but no doubt a much better road could be found.

Should the field prove to extend far to the Eastward there is no doubt but that a branch line would be run from the Great Southern, as the country is comparatively flat.

Timber and Water.

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

As to the question of water, it is in such abundance that it will probably be a great source of trouble in some places, but when a coal seam is met with in the solid country, between two good shale beds, it will not come in so fast.

This field is now being tested by the Government.

IRON.

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

It occurs in many forms, but the chief are magnetite and hematite (black and red oxides), which occur in immense lodes, and would be of enormous value if cheap labour were abundant. There is enough to supply the whole world, should the present sources be worked out.

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

ANTIMONY.

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

ZINC.

Blende occurs in the Geraldton District, associated with galena, but not in sufficient quantity to be worth working. Lately a lode has been found a little to the Sonth of Perth, and the samples sent in assayed 75 per cent. of zinc. It also occurs with the galena at Cardnp.

MANGANESE.

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

MICA.

Very good mica has been found at Bindoon and also on the Blackwood River, and in many other places, often of considerable size and splitting well; the specimens are frequently much iron-stained, but, now that a use has been found for discoloured mica, it will pay very well for working, and it is certain to be far less stained, if not quite clear, when quarried below the depth to which it has been weathered.

ASBESTUS.

Specimens of very fair asbestns have lately been found in several localities.

KAOLIN.

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

GRAPHITE.

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

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

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

APPENDIX I.

INFORMATION FOR PROSPECTORS.

Geological Museum; the Assay and Analytical Fees—Gold and Mineral Regulations—Prospectors' Outfit—Means of getting to places—Prospecting; a few tests—Tables of Weights and Measures.

THE MUSEUM.

The Museum occupies the large room in the Auxiliary Government offices in Beaufort Street (which was formerly used as the High Court of Justice). It contains the collections made by Dr. F. Von Sommer, by Messrs. Gregory Brothers, Captain Roe, by Mr. H. Y. L. Brown, F.G.S. (now Government Geologist of South Australia), by the late Mr. E. T. Hardman, F.R.G.S.I., who was Government Geologist in 1882 and 1883, and by the present Geologist, Mr. Harry Page Woodward, F.G.S., F.R.G.S. The Museum, the formation of which was entrusted to the Rev. C. G. Nicolay, M.A., was started originally at Fremantle, and a very good typical collection of the rocks and minerals of the Colony has been got together. In the year 1889 this collection was transferred by an order of the Governor-in-Council to the Government Geologist, and was removed to Perth. As the collection rapidly increased, and great interest was taken in it by miners and visitors to the Colony, it was found necessary at the commencement of 1891 to appoint Mr. Bernard H. Woodward, F.G.S., Curator. The collection includes most of the specimens that were sent to London for the Mining and Metallurgical Exhibition, held in the Crystal Palace, London, in the summer of 1890, where Western Australia took the third place amongst the British colonies for mineral exhibits. To this collection in 1892 was added general collections formerly exhibited at the Mechanics' Institute. The Museum is open to the public on Wednesdays and Saturdays from 10 a.m. to 1 p.m., and 2 p.m. to 5 p.m.

The Curator will name any specimens from this Colony, brought or posted to him, free of charge when that can be done without assay or analysis. Any specimens of rocks, minerals, ores, or fossils from this Colony or other parts of the world, as gifts or loans to the collection will be most thankfully received. In the basement of the same building are situated the Metallurgical laboratories of the Geological Department, which contain six furnaces, and all the appliances needful for making assays, both by the dry and wet methods, as well as for gold melting and refining. These are under the charge of the Curator, who also fills the posts of Government Analyst and Assayer, as in addition to the above the Government have fitted up a chemical laboratory, with all the apparatus and reagents required for analytical work.

The Assay and Analytical Department.

This department is under Mr. B. H. Woodward, F.G.S., who will make assays or analysis at the following rates:—

For Assay of any West Australian Mineral, Rock, or Ore, for any Commercial Metal such as Gold, Silver, Lead, Copper, Tin, Iron, Zinc, Mercury, or Antimony, will be prepared by the Government Assayer for a fee of Five shillings for each Metal sought. Assays of any minerals not enumerated above, and qualitative or quantitative analysis of any substance from £1 1s. to £3 3s. by arrangement.

Directions for sending Samples.

1. Send from 3oz. to 4oz. of each sample.
2. Do not crush the sample unless you wish to send an average from a large quantity.
3. Wrap each sample separately in strong paper, enclosing a piece of white paper with the number of the sample and your own name.
4. Address the parcel to "The Government Assayer, Perth."

5. Send a letter at the same time to the same address, stating for what metals you desire the samples to be assayed, and enclosing the fees.
6. Always retain duplicate samples of whatever you send, marked with the same numbers, and dated.
7. Liquids to be sent in a clean bottle (stoppered if possible), and in the case of water half a gallon is required. All bottles should be sealed.

N.B.—The rate of postage is one penny for every 2 ounces and under.

LICENSE TO MINE FOR GOLD ON CROWN LANDS.

Miner's Right.

The Warden may issue documents, each of which shall be called a "Miner's Right," and any such document shall be granted to any person applying for the same upon payment of a sum at the rate of 20 shillings for every year for which the same is to be in force.

Privileges Conferred by a Miner's Right.

Any person who shall be the holder of a Miner's Right shall be entitled to take possession of, mine, and occupy Crown lands for mining purposes; to cut, construct, and use races, dams, and reservoirs, roads, and tramways, which may be required for gold-mining purposes, through and upon any Crown lands; to take or divert water from any spring, lake, pool, or stream situate in or flowing through Crown lands on a proclaimed goldfield, and to use such water for mineral purposes and for his own domestic purposes, and to use by way of an easement any unoccupied Crown lands; to cut timber on and to remove the same, and to remove any stone, clay, or gravel from any Crown lands for the purpose of building a residence or for mining purposes.

Gold Mining Leases.

It shall be lawful for the Commissioner of Crown Lands to grant to any person a lease of any Crown land for mining purposes for any term not exceeding 21 years, and to renew the same for any such term at the yearly rental of £1 per acre. No such lease shall embrace an area exceeding 25 acres.

Leases may be Surrendered.

Any lease may be surrendered at any time with the consent of the Warden, provided that at the time of the surrender the conditions thereof, on the part of the lessee, shall have been fulfilled, so far as the time which may have elapsed shall permit, and that all payments due in respect thereof, up to date, shall have been made.

Proclamation of Goldfields.

It shall be lawful for the Governor to proclaim any portion of Crown land to be a goldfield.

Size of Protection Area.

A miner desirous of prospecting may mark off and hold a protection area of the following dimensions, viz.—Beyond the limits of a proclaimed goldfield, 400 yards by 400 yards; within the limits of a proclaimed goldfield, and more than three miles from the nearest gold workings, 300 yards by 300 yards; not more than three miles, and more than one mile from such workings, 200 yards by 200 yards; not more than one mile, and more than 400 yards, 150 yards by 150 yards.

Must be Marked and Registered.

All protection areas must be marked at each corner with a post standing three feet above ground, and four inches in diameter, such posts to be kept uncovered and set in L trenches three feet long and six inches deep, and such marking shall be deemed a sufficient title for thirty clear days, subject to the labour conditions; after which all protection areas within the limits of a proclaimed goldfield must be registered. A notice shall be posted on some conspicuous part of the area with the names of the holders, the numbers and dates of their miners' rights, the date on which the area was taken up, and the date of registration.

Labour Conditions.

Every protection area must be worked continuously every ordinary working day after seven clear working days after marking, by at least half the number of miners whose names appear on the notice as the holders of the area.

Prospector must Report Finding Gold.

Within seven clear days after the finding of gold in apparently payable quantities within any protection area, the holder shall report the said finding at the Warden's Office, under pain of forfeiture of such area. The Warden shall then proceed to the ground, and if sufficient gold has been found to warrant it, he shall allot the prospectors a reward claim in addition to the number of ordinary claims to which they would otherwise be entitled.

What considered a Sufficient Working.

A claim or leasehold shall be considered as effectively worked when eight hours' *bonâ fide* work is performed thereon by the complement of men required by the Regulations, on every working day except Saturday, when four hours' work shall be considered sufficient.

ALLUVIAL CLAIMS.

Ordinary Alluvial Claims.

Ordinary alluvial claims shall be:—

For one man ... ... 50 feet by 100 feet.

Reward Claims.

The size of reward claims, which shall be given for the discovery of payable gold in any creek, river, or ordinary alluvial ground, shall be in proportion to the distance from the nearest occupied gold workings of the same description, and as follows:—

If distant over 400 yards ...	Two claims of one man's ground.
,, one half-mile	Three men's ground.
,, one mile	Four ,, ,,
,, two miles	Six ,, ,,
,, three miles	Ten ,, ,,
If beyond the limits of a goldfield	Twenty ,, ,,

QUARTZ REEFS.

Ordinary Quartz Claims.

The extent allowed for each miner in any ordinary quartz claim shall be 75 feet along the supposed line of reef by a width of 400 feet.

Reward Claims.

The reward claim which shall be given for the discovery of gold in apparently payable quantities on any new reef, or the re-discovery of the same on any reef previously occupied and abandoned, shall be in proportion to the distance from any reef being worked, and as follows:—

If distant less than 400 yards, 100 feet along the line of reef.

If distant more than 400 yards and less than one mile, 150 feet along the line of reef.

If distant more than one mile and less than two, 200 feet along the line of reef.

If distant more than two miles and less than ten, 300 feet along the line of reef.

If distant ten miles or more, 500 feet along the line of reef.

The width allowed in all these cases is 400 feet.

All the above rewards shall be in addition to what the parties would be otherwise entitled to in ordinary claims.

Number of Miners to be Employed.

Only one-half the number of miners to whom any quartz claim has been allotted need be employed thereon until it has been proved payable.

When payable the whole number must be employed.

Gold Mining Leases.

All ground held under a mining lease shall be worked by not less than one man for every three acres or part of three acres, unless exemption or partial exemption from work has been granted. Provided that no lease shall be worked by less than two men.

Rewards for Discoveries of New Goldfields.

A reward of not less than £500 and not more than £1,000 shall be paid to any person or persons who shall discover a goldfield—deemed by the Governor in Executive Council to be a payable goldfield—in any of the following divisions of the Colony, as defined by the Land Regulations of the 2nd March, 1887, namely:—

South-West Division		
Gascoyne	,,	(*Granted*)
North-West	,,	(*Granted*)
Eucla	,,	
Eastern	,,	(*Granted*)

Not more than one such reward shall be payable in respect of each of the said divisions.

LICENSE TO MINE FOR OTHER MINERALS THAN GOLD ON CROWN LANDS.

Mining Licenses.

The Minister, his Agent, or a Mining Registrar may, on payment of the sum of One pound, issue to any person, not being an Asiatic or African alien, a mining license under the provisions of the Act.

Such license shall continue in force for a period of twelve calendar months from the date thereof, and shall not be transferable. The holder of a mining license shall be entitled to take possession of, mine, and occupy such an area of Crown lands for mining purposes as is specified in the Regulations; provided that such area shall not be within a declared townsite.

Mineral Leases.

The Minister may, subject to the provisions of the Act and Regulations, grant to any person, not being an Asiatic or African alien, a mineral lease of any Crown land within a mining district, subject to certain exemptions, for mining therein or thereon for any mineral other than gold.

Leases and Licenses.

Leases for a term of 21 years, renewable at a rental of 5s. per acre per annum payable in advance, are applied for in the same manner as gold leases, but notice must also be given in a local newspaper. A lease of alluvial land will not be granted unless it has been already worked and abandoned, or great cost would be incurred in working it, or it be deep or excessively wet. The area for tin, silver, or antimony shall not exceed 40 acres. For other minerals, save coal, the area shall not exceed 160 acres. The length of the land shall not exceed twice its breadth, and if possible the land shall be rectangular. One man must be employed for every five acres or fraction thereof. Returns, verified by statutory declaration, must be furnished monthly, giving all particulars of ores raised.

A prospecting license for coal for 12 months, renewable, over an area not exceeding 640 acres may be applied for. A description identifying the land and a sketch plan showing its position and a fee of 6d. per acre must accompany the application. This license also gives a right of residence and depasturing stock. The licensee may apply for a lease not exceeding in area 320 acres. If, however, payable coal be discovered 15 miles from any payable coalfield or at a depth of 600 feet from the surface, an area of 640 acres may be applied for. A surveyed plan must be lodged within six months, if a Government surveyor be on the ground, otherwise, within nine months. A royalty of 3d. per ton is payable during the first 10 years, excepting where an area of 640 acres is held or may be applied for, when the royalty shall be only 1d. per ton for that period; the royalty for the remainder of the lease is 6d. per ton. If any other mineral be mined, an additional rental of 5s. per acre is payable.

Contiguous leases may be united upon application by three-fourths of the lessees representing three-fourths of the interest in each lease. Leases may be transferred by permission. The interest under a claim merges in the leasehold. If gold be found, a royalty of £1 per centum is payable. Any person may apply for a gold lease, but a lessee is entitled to priority in applying therefor. If a mineral district be proclaimed within a pastoral lease, the rent may be remitted.

Every application for a lease shall be accompanied with a deposit of the rent and survey fees (*see* Schedule B). The term of all leases shall be computed from the 1st day of January preceding the application. Rent is payable from the quarter day preceding the application. If the lease be not taken out, the rent and survey fees deposited are forfeited. If the application be refused after survey, the deposit of rent only will be returned. If withdrawn before survey, the survey fees only will be returned.

HINTS TO PROSPECTORS.

Prospector's Outfit.

With the exception of the Kimberley District, travelling in this Colony is perfectly safe; therefore, firearms are quite unnecessary; a gun is even a useless encumbrance, as so little game is to be met with.

As most of the mineral belts are a considerable distance from the coast, and the means of transport very poor, only what is absolutely necessary should be taken, and this question of what is absolutely necessary is very difficult to define and must vary a great deal according to where operations are intended to be carried on.

On all the well established fields everything necessary can be obtained, at rather high prices it is true, but then it pays a man better to give a little more for a thing where and when he wants it. We will, therefore, consider that it is intended to prospect a new district where there are only sheep farmers at present. Stations are sure to be met with, for all the country is taken up as far into the interior as there is permanent water, and should prospectors be induced to go further they still can make one of these homesteads their base of operations.

At these stations rations, clothes, medicine, etc., can be obtained, as there is always a stock kept of assorted stores; therefore, it is only necessary to be provided with enough of these to carry on from one station to the next.

A man would, therefore, require:—

A blanket.
Calico tent or fly, 6 x 8.
Change of clothes (shirt, trousers, and socks).
Shovel (pattern a matter of taste).
Pick do.
2 Dishes do.
Water-bag (canvas) (6 pints).
Billy can (1 quart or larger).
Rations—meat, flour, sugar, and tea.
Towel.
Sheath knife.
Pocket compass.

This list is for a footman, and anyone will find that it is quite heavy enough when you have to carry it all day under a semi-tropical sun; but when a man has horses, of course he can go in for a much more extensive outfit, as one good pack-horse will carry 200lbs.

Small things that a digger should never be without are a compass, magnifying glass, and magnet; the simplest way to carry a magnet is to magnetise a pocket knife.

As persons may be starting prospecting who have never been in the bush before, a list of clothes and rations required may be useful:—

One hat (soft felt, broad brimmed).
One strong pair of boots (shod).
Two pairs moleskin trousers.
Two cotton shirts.
Two flannel undershirts.
Three pairs of socks.
Three handkerchiefs (red cotton, large).
One towel.

One Week's Rations.

10lbs. meat.
10lbs. flour.
2lbs. sugar.
¼lb. tea.
Soap, salt, soda and acid, or baking powder.

Means of Getting to Places.

Yilgarn-Southern Cross and Coolgardie.—Train from Fremantle or Albany *viâ* Northam to Southern Cross, and by coach from the latter to Coolgardie, a distance of 110 miles further. There are some hotels on the road, but full information can be obtained at the Cross.

Traps and horses can also be purchased or hired, but as horse feed and water are very dear on the field, it is much more expensive than by train and coach. Teams charge £1 per head to carry a swag of 1cwt., and they take between a week and ten days to do the journey.

Murchison.—A.S.S. line to Geraldton, and either walk, ride, or drive 300 miles; a coach runs once a fortnight, but about 80 miles of railway to Mullewa will soon be completed. Provisions can be obtained all up the road from stations, and water at easy stages; good turn-out for horses.

Ashburton.—A.S.S. line to Onslow, then up the Ashburton between 200 and 300 miles; no conveyance, so must walk or buy horses; water at easy stages, and stores may be obtained at stations; good turn-out for horses.

Pilbarra.—This includes Nullagine, Coongan, Marble Bar, &c. A.S.S. line to Cossack, tram to Roebourne; at this point horses or traps may be purchased, or go by Marble Bar mail coach; the Nullagine is about 300, and Coongan about 200 miles. The road is well watered, and stores can be obtained at stations and on the field; good turn-out for horses.

Kimberley.—The field is about 250 miles from Wyndham, at which port the A.S.S. boats call about once a month. There is no conveyance, and as horses are difficult to obtain, it is best either to make arrangements to go out with the mail man or some of the carriers. The road is well watered, but provisions are not to be obtained on the road.

Greenbushes Tinfield.—Train or steam boat to Bunbury. From Bunbury to the tinfield, a distance of between 60 and 70 miles, by railway and coach.

Dundas Hills are about 160 miles North of Esperance Bay, or about 400 miles by road North-East from Albany; it is difficult to get to at present, as the roads are bad and water and feed are scarce, except in the spring time. The "Grace Darling," schooner, leaves Albany for Esperance Bay on the 2nd of each month.

Horse Shoe Bend and Robinson Ranges are at the head of the Murchison River.

The Collie Coalfield is about 25 miles from the Collie bridge, on the South-Western Railway, or 40 by road by Bunbury; would have to hire trap and horses at Bunbury.

Prospecting.

Prospecting in an almost unexplored country like Western Australia is not by any means the pleasant work some people suppose it, for although, as a rule, there are no hostile tribes or wild beasts to be encountered, every man carries his life in his hand, and is always haunted by the most frightful death of which so many poor fellows perish, namely, want of water.

The greatest difficulties to be contended with may be put down as, want of topographical knowledge, great distances to travel, the scarcity of water and horse feed.

Before starting on a prospecting trip it should be ascertained that one of the party possesses a good knowledge of the general character of mineral country, is acquainted with a few rough tests, and has a knowledge of the different ores, whilst another should be a good bushman.

In prospecting a new country the prospector must divest himself of all the popular theories he has learned on another field, and be prepared to find the conditions under which the minerals exist apparently quite different. After finding a likely-looking belt of country, he should prospect it, and if he finds the object of his search, no matter if the lodes do not dip or strike in the direction he considers they should, or the rocks and vein stuff are not quite to his taste, he should give it a thorough trial before he condemns it, as no two districts in the world are precisely the same. This is particularly striking in this Colony, so much so in fact that the diggers have formed a theory that it has been turned upside down.

Alluvial.

In prospecting, the greater specific gravity of the metals over earthy matter is taken advantage of, for, in the first place, Nature will have roughly sorted the heavier material from the lighter, the streams leaving the heavier near the lode, whilst the lighter they will have carried further. Then, again, the heavier will be found deposited in the pockets and on the bottom of the stream beds, whilst the sand and clay will overlie it.

Although particles of most metals are found in the alluvium, only gold and tin have been worked at a profit, so we will confine ourselves principally to the consideration of these two; but should particles of other ores or coal be discovered, they should be traced up to their source.

The prospectors will first, then, look for a promising belt of mineral country. These are generally broken and rough or open alluvial flats, with here and there low outcrops, the rocks being clay slate, sandstone, quartzite, schist, &c., with quartz and ironstone veins and igneous dykes.

The quartz reefs should be well defined, and should not be of a highly crystalline or glassy nature, but from dead white to blue, iron-stained, gossany, and containing specks of other minerals, with lines in the stone which follow the strike of the reefs.

In such country as this the stream beds which cut across these reefs should be tested for gold. This is done by sinking small holes until the "wash dirt" (a gravelly deposit), which rests upon the "bed rock" (slate, &c.), is reached, when a sample should be tried from the bottom and from the crevices in the slate.

The dirt, when first introduced into the dish, is puddled and washed until the whole is free and the water remains clear, all the clayey matter having been washed away. Then the dish is again filled with water, and agitated with a circular motion, holding the dish level at first, but gradually inclining it to the side on which there is a little groove in the rim, allowing the water to overflow, after which all the upper coarser material is scraped off with the hand. This process is repeated several times, until only a small quantity of fine, heavy dirt is left, when it is finished by dipping the side of the dish under water and carefully floating or running off all the lighter matter; the gold being so much heavier, if present, it will hang back on the dish or in the little ledge in the rim. When this is sufficiently reduced, if no gold is visible to the naked eye, a glass can be used, and if any specks are visible it proves that gold exists in the neighbourhood, and further prospecting should be done up stream. This washing is very simple when once the knack is acquired, but the knowledge of the class of country to prospect and to be able to tell bottom when obtained are matters of experience.

Owing to the scarcity of water in this country washing is rarely possible, so that "dry-blowing" has to be resorted to; in this process two dishes are required, and often a coarse riddle. The dirt is first either sifted, or the large stones picked out; then, having chosen an airy position, the operator places an empty dish at his feet whilst the full one he raises above his head, gradually discharging its contents in such a manner into the one on the ground that the wind carries away to one side, beyond the dish, all the dust and lighter material. This process is repeated several times, and the larger stones picked out, until the dirt is reduced to a small compass, when the dish is shaken much in the same way as in washing, and the upper lighter material either brushed off with the hand or blown off by the mouth, when the gold will be found at the bottom of the dish. This process, of course, is not nearly so perfect as washing, and a great deal of the fine gold is lost; but when water is scarce it has proved a good substitute for washing, and is generally employed on the goldfields of this Colony.

Although gold is often found in payable quantities in highly Metamorphic country, where mica slates, mica, and hornblende schist replace the clay slates, still there is always a character about it that a gold-digger of any experience would never pass over, although it is impossible to attempt to describe. It may, however, be taken as a general rule, that gold in payable quantities is very rarely found amongst hard crystalline granitic rocks, and when it does occur is associated with a great deal of pyrites. Another thing to be noticed is that all rocks which run in straight lines and break into flaggy pieces are not slate, and all other rocks that are not slate need not necessarily be either granite or basalt, as seems to be a very general idea.

Stream tin is prospected for much in the same manner as alluvium gold, the only difference being that it must occur in much larger quantities to make it pay, and that being so much lighter than gold it is much more difficult to save and separate from other minerals. The class of country in which it occurs is generally of a more highly altered character than that which carries gold, the rocks being more granitic in character, the tin being mostly derived from veins in the soft white granite dykes themselves, whilst the surrounding country is generally hard and rocky.

Lodes are either found by tracing up the fragments derived from them in the stream beds until no more is met with, when we know that we must be near the lode, the fragments increasing in quantity and size as the lode is approached; or by finding the outcrop of a lode themselves, across the country, when they may be tested directly. With most of the minerals, the metal or ore predominates in quantity over the vein stuff, which may be quartz, flux or spar, calcite, &c., when they are then called lodes, but when, as with gold, the earthy matter is in the greater proportion, they are called reefs. Lodes are often covered at the surface by a cap of oxide of iron (iron hat), which can generally be traced with ease for a considerable distance at the surface; but the nature of the lode can only be discovered by opening it up, and even then, with the exception of copper or lead lodes, assays are necessary to determine their composition, as large quantities of gold, silver, cobalt, &c., may be contained without being visible.

The presence of gold may generally be determined by pulverising the stone and working it in the same manner as alluvial wash dirt, whilst samples supposed to contain tin must be assayed to determine what percentage of metal they contain.

The mineral in a lode does not, as a rule, run uniformly rich all through, but occurs in what are called shoots or bunches, whilst other portions are often quite barren. These shoots or bunches are very similar, and can, as a rule, be traced with the greatest ease after a little study, as they are found to behave in a similar manner in all veins of one series in a district. To understand this thoroughly seems at first a little complicated, as we speak of the lode dipping, say North, and the shoot West; but this can be demonstrated at once by taking a sheet of paper and drawing a line across it from the top right-hand corner to the bottom left-hand, call the right-hand side the East, and the line will represent the shoot; now raise the paper first vertically in front of you, keeping the East in the right hand, and, as you are naturally facing the North, let the paper incline over towards you: this now gives you an inclined plane dipping North, with a line to represent a rich shoot dipping West.

True veins do not generally follow the strike of the rocks, and there is more chance of finding this class of lode permanent in depth than interbedded lodes, although the latter, in some instances, are also true lodes, but, as a rule, these latter are of very variable size, and often pinch out.

Should a lode pinch out, great care should be taken in following any little stray leader or face until the lode is again found, as true veins, with good striated casing, do not end suddenly in this way, but only pinch to make again. In the case of a lode suddenly cutting out by a fault or trouble, we have, fortunately, an almost certain rule to guide us to its re-discovery, as we find that in 99 cases out of a hundred the beds on the upper side of the fault have slipped downwards. Therefore, should we, in working a lode or seam, come to a fault or face cutting out the lode, which, on examination, prove to dip away from us, we should follow it down, but if, on the other hand, it dipped towards or under us, we should follow up the fault plane to look for the missing lode. The distance of the throw it is impossible, in the general way, to ascertain without the series of beds are known.

A prospector having discovered a lode, the first thing for him to determine is the size of the lode and shoot, extent in depth, value, the expenses in working, water supply, fuel, timber, distance from port of shipment, means of carriage, and market for the commodity. All these should be carefully considered by the prospector, who, as a rule, has not sufficient capital to open a mine himself, so will require assistance from outside. He must assure himself that his discovery will pay to work before he wastes any time or money on it, or rushes into company-making. This it is very difficult for him to do, as one is always inclined to believe what one hopes, and others are always to be found who will back him up in this idea, simply with the object of making something out of it by floating a mine, which they know perfectly well will never pay, and it is not until the unfortunate prospector has spent all the money he had that he realises that his mine is of no value.

Coal Seams.

Coal seams may be prospected for in a similar manner to lodes, either by tracing fragments derived from their outcrops up the stream beds, or by finding the outcrop itself in their banks or beds, when, as in the case of lodes, they must be opened up to determine their thickness and quality of the coal, whilst bores must be put down to test underlying seams.

Tests.

The following are a few rough tests which may be employed in the bush:—

First note the appearance, whether metallic or not; the colour, the specific gravity *(roughly whether heavy or light)*; the hardness may be tested with a pocket knife and pieces of quartz, glass, and copper coin; the appearance of some of the mineral finely powdered, whether malleable or magnetic, if possible the effect of nitric acid and the effect of fire. For these tests all that will be required are a hammer, a knife (which should be magnetised by rubbing it on a magnet); a magnifying glass, and some nitric acid, the latter if possible.

Minerals with Metallic Lustre.

Colour.	Specific Gravity.	Hardness.	Colour of Powder.	Colour when burnt.	Magnetic or not.	Name.
Golden	19·3	2·5	(Malleable)	Golden	No	Gold
,,	8·9	3·0	,,	Blackens	,,	Copper
,,	4·3	3·5	Green Black	,,	,,	Copper Pyrites
,,	4·9	6·5	Brown Black	Red Brown	,,	Iron Pyrites
Silver	21·0	4·5	(Malleable)	Silver	,,	Platinum
,,	10·5	2·5	,,	Blackens	,,	Silver
,,	11·4	1·5	,,	Melts	,,	Lead
,,	7·5	4·5	Red	Red	,,	Specular Iron
,,	4·5	2·0	Grey	Volatile	,,	Antimony Ore
,,	7·5	2·5	,,	Fuses	,,	Galena

Minerals without Metallic Lustre.

Black	4·82	2 to 5	Black	—	,,	Manganese
White	6·4	3·5	White	Fuses	,,	Carbonate of Lead
Red	9·0	2·5	Red	Volatile	,,	Cinnabar
Green	3·8	3·5	Pale Green	Blackens	,,	Carbonate of Copper
Blue	3·7	4·0	Bluish	,,	,,	,,
Brown	4·5	6·5	Red	Unaltered	,,	Hematite
White, Yellow, Green, Brown, Black	4·0	3·5	Brown	—	,,	Sulphide of Zinc
Brown Black	7·0	6 to 7	Grey	Unaltered	,,	Tin Ore

Weights and Measures.

Measure of Length.

Inch.		Link.		Foot.		Yard.		Rod, pole, or perch.		Chain.		Furlong.		Mile.
7·92	=	1												
12	=	1·515	=	1										
36	=	4·545	=	3	=	1								
198	=	25	=	16½	=	5½	=	1						
792	=	100	=	66	=	22	=	4	=	1				
7,920	=	1,000	=	660	=	220	=	40	=	10	=	1		
63,360	=	8,000	=	5,280	=	1,760	=	320	=	80	=	8	=	1

Special Measure of Length.

6 feet = 1 fathom
6082·66 feet = 1 nautical mile
3 nautical miles = 1 league
60 nautical miles or 69·121 English miles } 1 degree
360 degrees = the earth's circuit.

SURFACE OR SQUARE MEASURE.

Sq. inches.	Sq. foot.	Sq. yard.	Sq. rod, pole, or perch.	Sq. chain.	Sq. rood.	Acre.	Sq. mile.
144	1						
1,296	9	1					
39,204	272¼	30¼	1				
627,264	4,356	484	16	1			
1,568,160	10,890	1,210	40	2½	1		
6,272,640	43,560	4,840	160	10	4	1	
		3,097,600	102,400	6,400	2,560	640	1

MEASURE OF CAPACITY.

Solid Measure.

1,728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
42 cubic feet = 1 ton of shipping.
13·17 cubic feet = 1 ton of quartz.
40 cubic feet = 1 ton rough timber.
52 cubic feet = 1 ton hewn timber.

Liquid and Corn Measure.

Gill.	Pint.	Quart.	Gallon.	Peck.	Bushel.	Quarter.
4	1					
8	2	1				
32	8	4	1			
64	16	8	2	1		
256	64	32	8	4	1	
2,048	512	256	64	32	8	1

AVOIRDUPOIS WEIGHT.

Grains.	Drams.	Ounces.	Pounds.	Stones.	Quarters.	Cwts	Tons.
27·34,375	1						
437·5	16	1					
7,000	256	16	1				
98,000	3,584	224	14	1			
196,000	7,168	448	28	2	1		
784,000	28,672	1,792	112	8	4	1	
15,680,000	573,440	35,840	2,240	160	80	20	1

TROY WEIGHT.

	Carat.	Dwts.	Ozs.	Lb.
3·2	1			
24	7½	1		
480	150	20	1	
5,760	1,800	240	12	1

MEASUREMENT AND WEIGHT OF WATER.

Weight.				Cubic Measure.			Liquid Measure.			
Tons.	cwt.	lbs.	oz.	cub. yd.	cub. ft.	cub. in.	gall.	qrt.	pints.	gills.
0	0	0	·57872	0	0	1	0	0	0	0·125
0	0	0	5·0	0	0	8·665	0	0	0	1
	0	0	6·944	0	0	12	0	0	0	1·5
	0	1	0	0	0	27·648	0	0	0	3·162
	0	1	4	0	0	34·659	0	0	1	0
	0	2	8	0	0	69·318	0	1	0	0
0	0	10	0	0	0	276·48	1	0	0	0
0	0	62	8	0	1	0	6	1	0	0
0	1	0	0	9	1	1382·4	11	0	1	2·5
0	15	7	8	1	0	0	168	3	0	0
1	0	0	0	1	8	0	224	0	0	0

Gold Valuation Table.

Value per oz. £	s.	d.		Value per dwt. £	s.	d.		Value per grain. £	s.	d.
4	0	0	...	0	4	0	...	0	0	2
3	17	6	...	0	3	$10\frac{1}{2}$	...	0	0	$1\frac{15}{16}$
3	15	0	...	0	3	9	...	0	0	$1\frac{7}{8}$
3	12	6	...	0	3	$7\frac{1}{2}$	...	0	0	$1\frac{13}{16}$
3	10	0	...	0	3	6	...	0	0	$1\frac{3}{4}$
3	7	6	...	0	3	$4\frac{1}{2}$	...	0	0	$1\frac{11}{16}$
3	5	0	...	0	3	3	...	0	0	$1\frac{5}{8}$
3	2	6	...	0	3	$1\frac{1}{2}$	...	0	0	$1\frac{9}{16}$
3	0	0	...	0	3	0	...	0	0	$1\frac{1}{2}$

For every rise or fall in the value of gold of one shilling per ounce gives a difference of $\frac{6}{10}$ of a penny per dwt. and $\frac{1}{40}$ of a penny per grain.

APPENDIX II.

GLOSSARY OF MINING TERMS.

Acicular.—Needle-shaped.

Acid.—A sour substance, which combines with metals, forming salts.

Adamantine.—The brilliant lustre like that of a diamond.

Adit.—A level driven into a mine from the side of a hill.

Aerolite.—Masses of metal, stone or carbon that have fallen from the air, also called meteorolite.

After Damp.—"Choke damp" or carbonic acid gas occurring in a mine after an explosion of "fire damp."

Agate.—A banded form of quartz.

Agglomerate.—Accumulations of angular fragments of rock thrown up by volcanic eruptions.

Alabaster.—A mottled massive form of gypsum used for carving.

Alkalies.—A group of minerals which possess the power of neutralising acids, and turn red litmus blue.

Alloy.—A mixture of two or more metals fused together.

Alluvium.—A deposit formed by streams.

Amalgam.—Mercury in which some other metal is dissolved.

Amygdaloid.—A volcanic rock, in which the almond-shaped gas cavities have been filled with some other mineral.

Anhydrous.—Minerals which do not contain water in chemical combination.

Anneal.—To temper by heating and gradually cooling.

Anthracite.—A highly mineralised form of coal. Steam coal.

Anticlinal.—When the strata assume an arch-shaped form.

Aqua Fortis.—Nitric acid.

Aqua Regia.—A mixture of one part concentrated nitric acid and three parts hydrochloric.

Aqueous.—Applied to stratified rocks deposited by water.

Arborescence.—Having a tree-like appearance. Dentritic.

Arenaceous.—Sandy.

Argentiferous.—Containing silver.

Argillaceous.—Clayey.

Arrastra.—A round fixed iron pan, in which ore is ground with mercury by revolving weights.

Artesian.—Wells are called artesian when they overflow at the surface.

Asbestos.—A form of hornblende of a whitish colour which will split up into silky threads.

Asphaltum.—A bituminous substance derived from the distillation of lignites and coal.

Assay.—The determination of the quantity of pure metal in an ore or alloy.

Atom.—The smallest quantity of an element that will combine with one or more atoms of other elements.

Attal or Addle.—Mine waste.

Auriferous.—Containing gold.

Axis.—The centre of an anticlinal fold, or of a crystal.

Azoic.—A term applied to a series of rocks, the age of which is unknown, such as granite, gneiss, mica schist, etc., in which there are no organic remains.

Back.—The top section of a lode, between the surface and the first level. Joints running in more or less parallel lines with the formation.

Backing.—Timbering at the top of level let into nitches in the rock.

Bar.—A hard band of rock, generally a dyke crossing a lode or stream bed.

Basalt.—A volcanic rock often occurring over a great extent of country or covering old stream beds.—" Bluestone."

Bassit.—Outcrop of lode.

Batter.—The sloping sides of a tank or dam.

Battery.—A stamper mill.

Bed.—A layer of rock of uniform homogeneous texture.

Bedan.—A round revolving iron inclined pan in which ore is ground with mercury by an iron ball.

Bed Rock.—The formation underlying the alluvium on which the auriferous wash dirt rests.

Bell Metal Ore.—Sulphide of tin.

Belly.—A bulging mass in a lode.

Bind.—A compact shaly rock. Application of this term varies.

Bitumen.—Mineral pitch.

Black Band.—Carbonate of iron found in coal measures.

Black Jack.—Zinc blend or sometimes tourmaline.

Black Sand.—Either iron, titanic iron, tin, manganese, or other fine black heavy sand accompanying gold.

Black Tin.—Dressed tin ore.

Blaes or Blaize.—A dark bituminous shale.

Blanketings.—The heavy sand caught by the blankets on the amalgamating table.

Blast.—To break by means of an explosion. A furnace into which a jet of air is blown.

Blind Coal.—Anthracite, or any coal that burns without a flame.

Blue Elvan.—Diorite or greenstone.

Blue John.—Fluor spar.

Bluestone.—Sulphate of copper or blue vitriol, also basalt.

Blue Vitriol.—Sulphate of copper.

Bonanza.—A large deposit of rich ore.

Boning Rod.—A "T" shaped instrument used for levelling.

Bort.—A black variety of diamond.

Botryoidal.—Having a rounded appearauce like a bunch of grapes.

Bottom.—The rock formation below the alluvium on which the gold or tin is found.

Boulder.—A detached rounded mass of rock.

Branch.—A small vein of ore shooting off from the main lode into the country.

Brass.—An alloy of zinc and copper.

Breast.—Face or front of coal seam being worked.

Breccia.—A conglomerate composed of angular fragments.

Brick-earth.—A clay suitable for making bricks.

Bronze.—An alloy of tin and copper.

Brown Coal.—A modern coal lacking the shining black colour of the older coals.

Brown-spar.—A name given to the browu crystalline forms of dolomite.

Brown-stone.—Limonite, brown iron ore.

Buck.—A name given to large barren quartz reefs.

Buddles.—Pans, with rapidly revolving agitators, into which tailiugs or water from ore dressing pass before being finally run away.

Bunch.—A small rich patch in a lode.

Bunny.—A mass of ore lying off the vein.

Burrow.—A heap of deads or refuse on the surface.

Cage.—The car or carrier used to hoist men or trucks in up the shaft.

Cainozoic.—The more modern geological formations.

Calcareous.—Containing lime.

Calcine.—To roast gently in the presence of air in order to oxidise certain minerals and to drive off volatile matter.

Calcite.—Carbonate of lime.

Cam.—A curved tooth fixed on a shaft, which rises the stamps.

Cannel Coal.—A highly bituminous coal used for making gas.

Canyon.—A valley between perpendicular cliffs.

Cap.—Decomposed vein stuff capping a lode.

Capel.—A hard stone lining at the sides of a tin lode.

Carat.—A weight used iu weighing precious stones nearly equal to 4 grains; also a term used to denote the fineness of gold, 24 carat being taken as pure gold, whilst 18 carat means 18 parts pure gold and 6 of some other metal.

Carbonate.—A chemical compound of carbonic acid and a base.

Carboniferous.—A formation in which the true coal measures are found.

Carn or Cairn.—A heap of stones used as a land mark.

Cases.—Fissures through which water runs into a mine.

Casing.—The clayey matter between a lode and the country.

Caunter.—A small cross lode.

Cellular.—Full of small cells or sponge-like.

Cement.—A hard alluvial deposit, often a conglomerate.

Chalybeate.—Springs, the water of which contains iron.

Chert.—Hard portions occurring in limestone, often flinty.

Chillian Mill.—A revolving iron pan, the ore being crushed by two stationary wheels, which revolve on the bottom of the pan.

China Clay.—The finer varieties of kaolin.

Chloride.—A chemical compound of chlorine with another element.

Chlorite.—A soft green mineral often met with in lodes.

Choke-damp.—Carbonic acid gas resulting from a gas or dust explosion in a mine.

Classing.—Sorting ore according to its quality.

Cleavage.—The manner of splitting.

Cleat.—A wedge.

Clinker.—Slaggy ferruginous masses found in a forge.

Coal.—A vegetable fossil fuel of commercial value.

Cob.—To break into small lumps.

Coffers.—The box or mortar in which the stamps work.

Coffin.—Old open workings.

Colour.—A small particle of gold.

Conglomerate.—Gravel cemented by either ferruginous, calcareous, silicious, or some other matter.

Contact.—A lode of great length in contact with two kinds of rock, one of which is generally intrusive.

Contour.—The outline or shape. Generally expressed by lines which follow round the outline of a hill at certain levels.

Copi.—Gypsum generally much weathered.

Copperas.—Green vitriol. Sulphate of iron. Used in making ink.

Corundum.—Sapphires, rubies, and emery consist of corundum, and it is the next hardest thing to a diamond.

Cord.—Used in the measurement of firewood; 128 cubic feet.

Corve.—A small underground wagon.

Costean.—A trench cut across country to search for a lode.

Country.—The rock formation at the sides of a lode.

Course.—A vein or lode, or the direction taken by them.

Cradle.—A woollen rocking machine for washing gold dirt.

Creep.—A rising of the floor of a drive or level caused by the vertical and latteral pressure of the rock.

Creek.—A small watercourse running into a river valley.

Cross-course.—Lodes crossing the main lodes at an angle.

Crosscut.—A level or drive driven through a lode at right angles.

Crucibles.—Pots used for smelting substances in a furnace.

Crystal.—The definite geometrical form with plane faces assumed by minerals.

CRYSTALLINE.—A rock, the structure of which has been altered into an aggregation of small crystals.

CUBE ORE.—Pharmacosiderite. Arseniate of iron, olive green, and occurs in cubes.

CUPRIFEROUS.—Containing copper.

CUT.—To drive to or across a lode.

CUTTERS.—Joints or cracks which cut across the strike of the lode or country.

DAM.—A barrier to keep back air or water.

DAMP.—Gases in a mine, as choke damp, which extinguishes a flame, and fire damp, which explodes when brought in contact with a naked light.

DAN.—A tub or truck without wheels, but on runners.

DAY.—That part of a mine where daylight penetrates.

DEAD GROUND.—That part of the lode where there is no ore.

DEAD WORK.—The development of a mine when no ore is being raised.

DEADS.—Refuse from a mine not containing ore.

DEAN.—End of a drive.

DEBRIS.—Loose pieces of stone or decomposed rock.

DECEMINATED.—Scattered through a substance.

DECREPITATE.—To crackle and fly to pieces when heated.

DENDRITE.—A moss-like appearance, occurring on the surface of fissures and joints in rocks.

DENUDATION.—The wearing away of rocks by the action of the weather or streams.

DERRICK.—A pulley fixed on a scaffolding over a shaft, the kibble or cage being drawn up by a horse or a winding engine.

DETRITUS.—Accumulations arising from the disintegration of rocks.

DEVIL'S DICE.—Cubes of brown iron ore, pseudomorphs of pyrites found in alluvial workings.

DIAL.—A form of compass used in surveying mines.

DIAPHANOUS.—The power possessed by a substance to transmitting light.

DILUVIUM.—As opposed to alluvium; used to denote deposits formed by powerful aqueous agencies, as floods, &c.

DIORITE.—An intrusive rock often called greenstone.

DIP.—The inclination of the strata or lode from the horizontal.

DIRT.—The auriferous gravel, wash, or pay dirt.

DISK.—The projecting plate on a stamp shaft caught by the cam.

DISH.—An iron pan used for washing dirt in.

DISINTEGRATION.—The breaking up of solid matter.

DIVINING ROD.—A "V" shaped hazel rod, by the aid of which some persons profess to be able to tell where minerals and water lie below the surface by a process of divination.

DOLERITE.—A variety of basalt, called also bluestone.

DOLLY.—To break up quartz with a piece of wood shod with iron in order to be able to wash out the gold.

DOLOMITE.—Magnesian limestone.

DONK.—Clayey or earthy matter found in cross veins.

DOWSING ROD.—A "V" shaped twig used for finding water or mineral.

DRESS.—To sort ore.

DRIFT.—Loose alluvial deposit. A level or drive in a mine.

Drill.—A steel bar with a chisel end, which is struck on the other end by a hammer; used in mines for making a hole to put an explosive into.

Drive.—A level, drift, or tunnel in a mine.

Dropper.—A shoot of ore leaving the lower side of a lode.

Druse.—A cavity in a lode lined with crystals. Vugh.

Dump.—A place where ore taken from a mine is shot.

Dunes.—Blown sand hills.

Dyke.—An intruded vein of igneous or plutonic rock.

Element.—A simple substance, not a compound.

Elvan.—A hard felstone or porphyritic dyke.

Emery.—An impure form of corundum.

End.—The extremity of a drive.

Eolian.—Drifts which have been arranged by the wind.

Erosian.—The gradually wearing away of rock.

Erratic.—Masses of transported rock which do not belong to the rocks of the district in which they are found.

Eruptive.—Rocks which have poured from volcanoes in a molten state.

Escarpment.—A cliff or abrupt face of a ridge or hill range.

Estuary.—The tidal mouth of a river.

Exfoliate.—To fall off in laminæ or scales.

Face.—The end of a drive.

Fahlbands.—Parallel belts of rock impregnated with ore sufficiently rich to work.

False Bottom.—A bed of wash lying on the top of other alluvial deposits, beneath which there may be a true bottom on the bed rock.

Fahlore.—Grey copper ore.

Fang.—An air passage at the side of adit or shaft.

Fast.—Solid rock immediately beneath the surface.

Fathom.—Six feet.

Fault.—A line of dislocation of the strata.

Feeder, or Leader.—A small vein carrying ore coming into a larger one.

Feldstone.—A trap rock having a fine granular structure composed of feldspar.

Ferruginous.—Containing iron.

Fire-clay.—A clay that resists high temperatures without fusing.

Fire-damp (Light-carburetted hydrogen).—An explosive gas met with in coal mines.

Fissure.—A crack in the rocks.

Floating Reef.—Loose masses of auriferous quartz found in the alluvium.

Floor.—Where a lode has taken a turn and lies in a horizontal position.

Flookan or Flucan.—A soft clayey substance between the lode and the rock. Also called casing.

Flouring.—The breaking up of mercury or amalgam into very fine globules.

Fluke.—A rod for cleaning drill holes.

Flume.—An aqueduct for bringing water to the workings.

Foliated.—Composed of thin leaf-like layers.

Footwall.—The wall on the lower side of a lode.

Force Piece.—A diagonal timber in a shaft or drive.

Fork or Forcque.—The bottom of a sump, into which the water of a mine drains. To bale a shaft dry. A prop.

Formation.—A series of strata that have been deposited continuously over the same area.

Fossicker.—A mining gleaner who works over old diggings, and scratches about in the beds of creeks.

Fossil.—Petrified organic remains.

Frue Vanner.—A table over which a blanket passes in one direction whilst the whole has a lateral shaking motion, used for concentrating pulp and slimes.

Fuller's Earth.—A non-plastic unctuous hydrous silicate of alumina.

Fundamental.—A term applied to the oldest known rocks.

Fuse.—A slow match by which charges are fired, also to melt.

Fusible Metal.—A compound of bismuth, lead, and tin, which melts at a very low temperature.

Gad.—A steel wedge used in mining.

Gallery.—A level or drive in a mine.

Gang or Gangue.—The non-metallic portion of a lode.

Gas Coal.—A bituminous coal, such as cannel or parrot.

Gash Vein.—A simple fissure across the bedding of the rocks, without any throw or slide of the rocks.

Glance.—Minerals exhibiting a pseudometallic lustre.

Glist.—A dark ferruginous mineral found in lodes. Micaceous iron ore.

Gneiss.—A compact granitic rock, having a banded appearance.

Gossan.—Vein stuff stained with oxide of iron, found at the cap of a lode.

Granite.—A rock composed of quartz, felspar, and mica.

Graphite.—Plumbago or blacklead.

Grass.—At the surface of a mine.

Gravel.—Water-worn fragments of rock.

Greenstone or Diorite.—A stone of a greenish black colour, composed largely of hornblende, occurring in dykes.

Green Vitriol.—Sulphate of iron.

Grits.—Coarse sandstone.

Ground.—Rock at the side of a lode. Country.

Guag.—That part of the lode from which the ore has been taken out.

Gulch.—A deep ravine.

Gully.—A small water course falling into a creek.

Gutter.—Old stream bed on the bed rock, in which the gold is found below the alluvium.

Gypsum.—Sulphate of lime, plaster of Paris, or stucco, stone.

Hade.—The dip or underlie of a lode or fault.

Hematite—Native oxide of iron, red and yellow ochre.

Handwhip.—A contrivance for lifting water from a shaft by a lever and counter balance.

Hanging Wall.—The upper or head wall of a lode.

Harrow.—A pole with teeth in it, which revolves in a puddling trough to puddle auriferous clays.

Hat.—The cap of a lode.

Hatter.—A miner who works by himself.

HANDING.—Raising material from a mine.

HAZLE.—A mixture of sandstone and shale.

HEADINGS.—Coarse gravel above wash dirt.

HEAD RACE.—An aqueduct for bringing water.

HEAD SWORD.—Water discharged through an adit level.

HEAVES.—Faults or throws in a lode.

HEAVY GOLD.—When gold is found in large particles.

HEAVY SPAR.—Barytes.

HOLE.—To pick out the soft clay beneath a lode or seam preparatory to wedging or blasting the mass out.

HORIZON.—The stratigraphical position of a bed or series of beds of rock.

HORNBLENDE.—A mineral which imparts the greenish colour to diorite and many crystalline rocks.

HORNSTONE.—A hard flinty rock.

HORSE.—A mass of country rock splitting a lode.

HORSEFLESH ORE.—Purple copper ore.

HOVE.—A lode is hove or thrown in a certain direction by a fault.

HUEL, or WHEAL.—A mine.

HUNGRY.—Non-metalliferous lodes or belts of country are said to be hungry-looking.

HUNTINGTON MILL.—A mill in which the stone is ground against the sides of a fixed pan by revolving grinders.

HYDRAULICING.—Working an alluvial deposit by means of a jet of water.

HYDRAULIC CEMENT.—A cement that will set under water.

HYDROUS.—Minerals which contain water chemically combined.

IGNEOUS.—Rocks which have been deposited in a molten state.

INCANDESCENT.—White hot or glowing.

INCH (Miners') is the quantity of water that will pass through a horizontal slit 24 inches long by 1 inch high, whilst for pressure the water stands 6 inches above the hole; this gives 2,274 cubic feet in 24 hours.

INCLINE.—A slanting shaft.

INCRUSTATION.—A coating of foreign matter.

INDURATED.—Rocks that have been hardened by the action of heat.

IN SITU.—In the same place where it was originally deposited.

INTRUSIVE.—Rocks that have been thrust amongst others in a molten state.

IRIDESCENT.—Having a play of colours on the surface.

IRON PYRITES.—Yellow sulphide of iron, also called mundic.

IRONSTONE.—Iron ores or a substance containing a good deal of iron and being stained by it.

JADE.—A green variety of hornblende largely carved in New Zealand.

JASPER.—A red or yellow viliceous rock containing a little clay and oxide of iron.

JET.—A compact, highly lustrous variety of lignite.

JETTERS.—Rods connecting a water wheel with a pump.

JEWELLER'S SHOP.—Very rich patch in a gold mine.

JIGGER.—A machine for dressing small ore in which a sieve is dipped or moved about in water.

JOINTS.—Cracks or partings across the bedding planes of rock.

Judge.—A staff used in measuring underground.

Jump.—To take possession of a claim, the property of others, on legal grounds.

Jumper.—A long drill by which a hole is made by letting it fall, instead of striking it with a hammer.

Junction.—The union of two lodes.

Kaolin.—China clay. Decomposed feldspar.

Kerosene.—A mineral oil distilled from a bituminous shale.

Kibbal or Kibble.—A barrel used to bring up ore or water from a mine.

Kidney-iron-ore.—A variety of hematite named from its resemblance.

Killas.—Clay slate in mineral country.

Lacustrine.—Deposits which have accumulated in fresh water lakes or marshes.

Lamina.—Thin layers.

Lander.—Banksman who receives and lands the kibble at the top of the shaft.

Launder.—Troughs in which water is carried about a mine.

Lead.—A defined gutter of auriferous wash.

Leader.—A small vein running into a larger one.

Leat.—An aqueduct to a mine.

Ledge.—A lode.

Lenticular.—A deposit or lode which swells in the middle and tapers towards the edge.

Level.—A drive along the lode.

Lifts.—Pumps, or something which raises.

Ligneous.—Having a woody structure.

Lignite.—Brown coal. Modern coal showing a woody structure.

Likely.—A belt of country or a lode is said to be likely when there are indications of minerals.

Little Giant.—Nozzle of hydraulic hose.

Little Winds.—The smaller shafts on a mine.

Lime.—Calcined limestone or chalk.

Liver Ore.—A dark-coloured variety of sulphide of mercury.

Loadstone.—Magnetic oxide of iron.

Lob of Gold.—A small bit or rich deposit of gold.

Lock.—A cavity in a lode.

Lode.—A mineral vein containing ore.

Long Tom.—A trough for washing auriferous gravel.

Lousing.—Picking over by hand a heap of dirt on the surface of a rich claim.

Lydian Stone.—A black flinty slate used for testing gold on.

Magnet.—Substances which attract certain metals.

Malleable.—Anything that can be hammered out without cracking.

Man Engine.—A machine for lowering or raising men into or from a mine.

Marble.—A crystalline form of limestone.

Master Lode.—A large bedded vein.

Matrix.—The mineral matter of a lode, not ore.

Mercury.—Quicksilver.

MESOZOIC or SECONDARY.—The geological division between the Cainozoic and Palæozoic.

METALLURGY.—The extraction of metals from ores.

METAMORPHIC.—Changed or altered.

METEORITE.—Metallic masses that have fallen from the air. Aerolite.

MIA-MIA.—A bough shed over a shaft.

MICA.—A mineral that will split up into thin transparent plates.

MICACEOUS.—Rocks consisting largely of mica, or minerals having a scaly appearance like mica.

MICE-EATEN.—Quartz full of holes.

MINERAL.—A term used to distinguish the inorganic portion of the earth from the animal and vegetable kingdoms.

MISPICKLE.—Arsenical pyrites.

MOUNTAIN BLUE.—Blue copper ore.

MOUNTAIN CORK.—Asbestos.

MOUNTAIN GREEN.—Green copper ore.

MOUNTAIN LIMESTONE.—Dolomite. Magnesian limestone.

MULLOCK.—A soft mass of country or decomposed dyke, containing gold or other metal. Also decomposed and broken rock mixed in a lode.

MUNDIC.—Iron pyrites.

MURIATIC ACID.—Hydrochloric acid. Spirits of salt.

NAPHTHA.—A liquid volatile, and highly inflammable variety of bitumen.

NEEDLE.—A small iron rod for making the touch-hole used in blasting.

NIP.—The pinching of a vein in passing through hard country.

NITRE.—Nitrate of potash. Saltpetre.

NODULE.—A small lump.

NUGGET.—A large solid mass of alluvial gold.

OCHRE.—Pigments mostly earthy oxides of metals.

OIL SHALES.—Highly bituminous shales, from which mineral oils are distilled.

OPALINE.—An earthy form of gypsum or magnesian limestone.

OPEN CAST.—When a lode outcrops at the surface and is taken bodily out without sinking a shaft.

ORE.—The portion of the lode stuff which contains the metal.

ORGANIC.—Of animal or vegetable origin.

ORPIMENT.—Yellow sulphide of arsenic.

OUTCROP.—When the lode or bed comes to the surface.

OVOID.—Egg-shaped.

OXIDE.—A compound of oxygen with a metal.

PADDOCK.—A way of working a claim, the whole mass being taken out in the form of a large square pit.

PAINT GOLD.—Very thin coatings of gold on the faces of stone.

PALÆOZOIC (Ancient Life).—The name given to the strata which contain the oldest forms of life, and it is amongst these that most of the mineral deposits are found.

PAN.—A dish for washing gold. Also to wash gold.

PARAFIN.—A wax-like substance obtained from the distillation of petroleum and other bituminous minerals.

Parcel.—A quantity of ore ready for sale.

Parrot.—A form of cannel or gas coal that burns with a crackly noise.

Pass.—A small passage left between the deads in a mine.

Pay Dirt.—Gravel containing gold.

Peachy.—Vein stone of a greenish colour due to chlorite.

Petrology.—The science of rocks.

Petering.—The pinching out of a vein.

Petroleum or Rock Oil.—A liquid mineral pitch or bitumen which oozes out and forms certain strata-like oil.

Phosphatic.—A compound containing phosphoric acid.

Physical.—Appertaining to nature.

Pick.—A mining tool. To sort out the best ore.

Pile.—A stack of ore or stones. A prop of timber. A fortune.

Pillar.—Part of the lode or seam left standing as a support.

Pinch.—A lode is said to pinch when it becomes small.

Pipe.—A narrow portion of rich ore running down the lode.

Pipe Clay.—An impure form of kaolin.

Piping.—Washing with a hose.

Placer.—Gold diggings or hydraulic mine.

Plaster of Paris.—Burnt sulphate of lime or gypsum.

Plastic.—Capable of being moulded.

Plat.—A place to receive ore, or rough bridge.

Plate.—Thin shales between limestones.

Plumbago.—Graphite or black lead.

Plumbiferous.—Containing lead.

Plunger.—The end of the pump rod which dips into the water.

Plutonic.—Applied to igneous rocks which were consolidated under great pressure at some depth beneath the surface.

Pocket.—A rich deposit of mineral, but not a vein.

Poppet Heads.—The top of a derick where the pulley is situated.

Porphyry.—A rock containing imbedded crystals distinct from the matrix.

Potstone.—A coarse granular variety of steatite or soap stones.

Powdered Ore.—Fine ore disseminated through a lode.

Pricker.—A thin rod for keeping an opening for the fuse through "tamping."

Primary.—The oldest series of rocks containing organic remains; palæozoic.

Product.—Per cent. of metal in ore.

Prospector.—A searcher for metals or minerals.

Pryan.—Clay.

Pseudomorph.—Casts of crystals composed of a different mineral.

Puddle.—To mix clay and water.

Pulverise.—To grind fine.

Pumice.—A cellular volcanic rock which is so light that it will float on water.

Purser.—The secretary or cashier on a mine.

Pyrites.—Yellow sulphide of iron; mundic.

Quarry.—A large open working with a roadway into it.

Quarry Lode.—A lode much broken by joints.

QUARTZ.—A silicious vein stuff occurring largely associated with ores.

QUARTZITE.—An altered sandstone in which the grains of sand have been cemented by silica.

QUARTZ ORE.—A rock containing a large quantity of quartz.

QUICKLIME.—Limestone from which the carbonic acid has been driven off by heat.

QUICKSILVER.—Mercury.

RACE.—An aqueduct to or from a water wheel.

RAG PUMP.—A chain passing through a pipe with pieces of rag here and there, which act as buckets or suckers.

RAKE VEIN.—A vein or lode cutting through the strata.

REALGAR.—Red sulphide of arsenic.

REED, RUSH OR SPIRE.—A reed filled with powder to act as a fuse.

REEF.—A quartz lode or vein.

REVERBERATORY.—A furnace with a large ore hearth on which the flame and furnace gasses are thrown.

RIB.—String of ore in a lode.

RIDER.—A mass of country enclosed in a lode. A horse.

RIFFLE OR RIPPLE.—Bars at the bottom of a sluice-box to catch the gold.

RISE.—An ascending gallery at the end of a level.

ROCK.—A geological term for the substances which compose the earth's crust.

ROCK SALT.—A massive form of common salt.

ROD SHAFT.—A shaft containing pump rods.

ROLLS.—Crushing rollers.

ROOF.—Overhead in a mine.

ROTTEN STONE.—A soft friable silicious earth used for polishing.

RIGHT LODE.—A true fissure vein.

RUBBLE.—Loose stones.

RUN.—Course of the lode or rich gutter (a run of gold).

RUNS.—Percentage of metal to ton of ore.

SALTPETRE.—Nitrate of potash.

SALTING.—Introducing rich mineral matter from somewhere else to make a mine appear richer than it really is.

SAMPLE.—Portion of ore for assay supposed to represent an average of the whole quantity.

SATIN SPA.—A fibrous form of gypsum.

SCALE.—The flakes and rubble that fall in after the ore has been removed.

SCHIST.—A rock with a foliated structure due to the minerals being in layers.

SCHORL.—An ashy or cindery character. Black tourmaline.

SEAM.—A bed of coal. A horse load of tin.

SEAT.—The bottom or roadway of a mine.

SECONDARY.—Geological period generally called Mesozoic, which embraces all the rocks between the tertiary and primary.

SECTILE.—Capable of being cut.

SEDIMENTARY.—Rocks which have been deposited from suspension in water.

SEGREGATION.—A natural law by which particles of an element or elements are attracted together, thus separating out from other substances in the mass.

SERPENTINE.—A magnesian silicate rock of Plutonic origin.

Set.—A frame of timber cut ready for putting into a shaft or drive.

Shaft.—A vertical or inclined communication from the surface into a mine.

Shakes.—A crack or fissure.

Shale.—A rock which weathers into thin flakes along the lines of bedding, mostly associated with the coal measures.

Shear Legs.—Three long poles fixed together at the top with a pulley suspended to stand over a shaft for hauling.

Shelf.—A ledge of bed rock upon which drift rests.

Shepherding.—Holding a mine or claim by doing as little work upon it as compelled by law.

Shift.—The time during which men work in a mine, generally eight hours.

Shoding.—Tracing pieces of detached vein stone to the parent lode.

Shoot.—The portion of the lode, of greater or less length, carrying the ore which generally dips as an inclined plane at an angle along the line of lode; a larger form of pipe.

Shot.—A charge of an explosive put into a drill hole.

Sickening.—A scum which forms on the surface of mercury from grease, sulphides, arcenides, etc.

Silicate.—A mineral of which silica forms a constituent.

Silicious.—Sandy or of a flinty nature.

Sink.—A sump or pit below a level. To excavate downwards.

Skips.—Trucks in a mine.

Slack.—Small coal. Quicklime after water is added.

Slate.—An argillaceons rock which splits into plates at right angles to the bedding.

Slickensides.—A polished or striated surface upon rock or in a mineral lode, due to a fault or slip.

Slide.—A small fault or disturbance in a lode.

Slimes.—The very finely-divided ore, which is most difficult to save.

Slip.—A fault.

Slip Vein.—A gash vein, accompanied by faulting, or dislocation.

Sluice.—A long trough with a loose bottom, on which there are small cross bars, or in which there are holes. Through this trough the wash-dirt is carried by a stream of water, the gold being left behind at the bars or under the false bottom.

Sludge.—Muddy matter.

Slug.—A piece of alluvial gold up to about 1lb. weight.

Smalls.—Small-sized pieces of ore, gangue, or coal.

Smutt.—Poor, dull, sooty portions of a coal seam.

Soapstone.—A soft, greasy, talcose rock.

Spalling.—Breaking up.

Spathic.—Of a sparry nature.

Specimen.—A lump of gold intermixed with quartz, or quartz very rich in gold.

Speck.—A small piece of alluvial gold weighing up to an ounce or two.

Specking.—Walking over the ground on the chance of picking up a lump of gold on the surface.

Spirits of Salt.—Muriatic or hydrochloric acid.

Splint, or Splint Coal.—A hard laminated variety of bituminous coal.

Spotted.—Leads in which the gold is in patches.

Sprag.—Small single props.

Squeezes.—A pinch of the vein in passing through hard bands of rock.

Stalactite.—Hanging columns of carbonate of lime formed by dripping water.

Stalagmite.—Pinnacles of carbonate of lime rising from the floor to meet the stalactite.

Stamp.—The weighted head or pestal in a battery for crushing ore.

Stanniferous.—Yielding or containing tin.

Steam Coal (Anthracite).—A non-bituminous coal.

Steatite.—A talcose rock. Soapstone.

Steel.—An alloy of iron and carbon.

Stein.—Stone-work used to secure the sides of a shaft.

Stockwerts.—A number of small strings of ore which can be worked together.

Stopes.—The workings in a mine between levels from which the ore is taken in a series of steps, called overhead or underhand stopes, accordingly as they are above, or below, a level.

Stratum.—When rocks lie in layers one above another, each layer forms a stratum, and the whole series the strata.

Streak.—The appearance of the surface of a mineral when scratched.

Streaming.—Separating ore from gravel by the aid of running water.

Stream Tin.—Tin ore occurring in stream beds in the same way as alluvial gold; term used to distinguish it from lode tin.

Striated.—Streaked or with lines running parallel to each other.

Strike.—A valuable discovery. The direction taken by the horizontal outcrop of a lode or rock.

String.—A thin course of ore.

Stulls or Stemples.—Staging on which rubbish is left in the workings of a mine.

Sulphate.—A compound of sulphur and oxygen with a metal.

Sulphide.—A compound of sulphur and a metal.

Sump.—A pit sunk at the bottom of a mine to collect water. To test the lode in depth.

Swallow.—A large cavity, mostly met with in limestone; useful for draining a mine.

Synclinal.—A trough-shaped curve of the strata.

Tackey.—Having a rough catchy surface.

Tailings.—Refuse from workings after the ore has been extracted.

TAIL RACE.—A channel for carrying away dirty water.

TALC.—A very soft mineral consisting of silica, magnesia, and water. It usually occurs in flakes of a greenish colour, is flexible, and has a greasy feel. Massive form called soapstone or steatite.

TALUS.—The sloping mounds of detritus which accumulate at the base of cliffs.

TAMPING.—Filling, or the material used in filling a drill hole in which an explosive is placed.

TAPPETS OR TONGUE.—A wedge used to secure the lifter on to the stamper.

TEARY GROUND.—Ground easily broken and worked.

TEMPER.—To reduce the hardness of steel by gently heating.

TENACITY.—The adhesion possessed by a substance or its toughness.

TERTIARY.—Cainozoic. A series of rock more recent than the secondary.

TERRA-COTTA.—Pottery made from a fine brick earth.

THERMAL.—Hot springs are called thermal.

THROW.—The displacement of the strata due to a fault.

THRUST.—A creep.

TILE ORE.—An earthy indurated incrustation of an oxide of copper and iron.

TITANIFEROUS.—Compounds of titanic acid.

TOAD STONE.—Interbedded veins of trap rock in the mountain limestone.

TON.—Long ton, 2,240lbs.; short ton, 2,000lbs; 50 cubic feet of wood or 13 cubic feet of quartz.

TORMENTOR.—A wooden roller studded with spikes; used for puddling.

TOUCHSTONE (LYDIAN STONE).—A black flinty slate used for testing gold.

TOURMALINE.—SCHORL.—A black mineral often mistaken for tin.

TRACHYTE.—A volcanic rock of a coarse cellular composition having a rough or gritty feel.

TRANSMIT.—The power of letting light through.

TRAP OR TRAPPEAN.—Igneous rocks that have cooled down under only slight pressure.

TRAVERTINE.—A surface limestone deposit, often nodular.

TREND.—The course of a vein.

TRIBUTE.—An agreement entered into between working miners and owner, by which the former are to give the latter a certain percentage of the ore raised.

TROUBLE.—A fault or throw.

TROUGH FAULT.—When a portion of the strata is thrown down between two adjacent faults.

TRUE LODE.—A fissure vein.

TUCKER.—A term used to denote that a miner is only making enough to keep him in food.

TUFA.—A soft limestone rock deposited by water.

TUNGSTATE.—A compound of tungsten.

TURBINE.—A wheel turned by water.

Turnhouse.—A point where workings turn for a cross-cut to a level along the lode.

Tut.—Work of development down in barren ground.

Underlie.—Angle at which a vein dips away from the surface.

Van.—To wash a small quantity of ore on a shovel to ascertain its richness.

Vanners.—Machine for dressing up finely powdered ore.

Vein.—A rent in the earth's crust filled with mineral matter.

Vein Stuff.—The portion of the lode which is not ore.

Vesicular.—Containing numbers of bubble-like cavities.

Vitreous.—Glassy.

Vitriol, Oil of.—Sulphuric acid.

Volatile.—When heated passes off as vapour.

Volcanic.—Igneous rocks which have been ejected from volcanoes.

Vugh.—A hollow or cavity in a rock or lode often lined with crystals.

Wad.—Black oxide of manganese.

Walls.—The boundaries between the rock and lode stuff, the upper being the "hanging," and the lower the "foot" or "heading" wall.

Wash.—To separate by water ore from refuse. The alluvial material amongst which gold or tin is found.

Waste.—Neglected workings in a coal mine.

Whele, Wheal, or Huel.—A mine.

Whim.—Machine for raising ore from a mine, in which the horse walks round and round.

Whip.—A pulley over which a rope passes, and is attached to a horse, which walks straight away, used for raising a bucket, at the other end, from a mine.

White Vitriol.—Sulphate of zinc.

Windlass.—A wooden roller with a crank at the end, used for winding a rope on, in hauling a bucket up a shaft.

Windsail.—A canvas pipe put down a shaft for ventilation.

Winze, or Winds.—A small shaft sunk from one level to another underground.

Wolfram.—Tungstate of iron and manganese. It is proposed to use this mineral as a projectile, on account of its great specific gravity.

Zone.—A name given to a series of strata distinguished by similar organic remains.

APPENDIX III.

SHIPPING FACILITIES, RAILWAY, POSTAL, AND TELEGRAPH SERVICE.

SHIPPING FACILITIES.

The shipping facilities possessed by Western Australia are considerable, when the small population of the Colony is taken into consideration.

The following are the principal companies connected with the shipping trade of the Colony; and their present passage rates and freights are also given as accurately as possible. These rates, however, it must be stated, are liable in every instance to alteration at any time as circumstances may seem to require.

Peninsular & Oriental S.N. Company.

The Mail Steamers of the Peninsular & Oriental S.N. Company, both homeward and outward bound, call in fortnightly at Albany.

Passage Money.

Between London and Albany (King George's Sound) and vice versâ.

First Saloon	... ...	£60 to £70.
Second do.	... ...	£30 to £37.
Return Tickets	... ...	£65 and £115.

Intercolonial Passage Rates and Freights.

	1st Saloon. Single.		1st Saloon. Return. Available 3 months.		2nd Saloon. Single.		2nd Saloon. Return. Available 3 Months.	
King George's Sound to—	£	s.	£	s.	£	s.	£	s.
Adelaide	9	0	13	10	7	0	10	10
Melbourne	12	0	18	0	8	0	12	0
Sydney	14	0	21	0	10	0	15	0

Agents—J. F. T. Hassell, Albany; Sir G. Shenton, Perth and Fremantle

The Orient S.S. Company.

The Mail Steamers of the Orient Line also visit Albany on alternate weeks to those of the P. and O.

Passage Money.

First Saloon ...	... ...	£63 and £70.
Second do. ...	... ...	£35, £37 and £40.
Third do. ...	... ...	£17 17s., £20 and £22.
Return Tickets	... ...	£65 to £115.

Intercolonial Passenger Fares.

Albany to—	1st Class.	2nd Class.	3rd Class.	Return.
Adelaide ...	£9	£7	£5 10s.	25 ℔ % off double fare.
Melbourne ...	£12	£8	£6 10s.	do.
Sydney ...	£14	£10	£7 10s.	do.

Agents—McKail & Co., Albany; J. Lilly & Co., Fremantle.

Messageries Maritimes Company.

The steamers of the *Compagnie des Messageries Maritimes* call in at Albany monthly.

Passage Money.

Between Albany and Marseilles, either way—

Single journey	£20 to £65.
Return	£34 to £115.

Through ticket, Marseilles to London (24 hours by rail), £5 first class; £4 second class.

Luggage is conveyed free by steamer from Marseilles to London.

Intercolonial Passage Rates.

Albany to—	1st Class. £ s.	2nd Class. £ s.	3rd Class. £ s.	Return.
Adelaide	9 0	7 0	5 5	25 per cent. off double fare.
Melbourne	12 0	8 0	6 10	
Sydney	14 0	10 0	7 10	
Noumea	24 0	17 0	8 0	

Agents—J. Lilly & Co., Fremantle.

Adelaide Steamship Company.

The Adelaide S. S. Company has a fleet of 8 vessels employed in the Coastal and Intercolonial trade of the Colony.

Amongst those generally employed, although of course they are always liable to be changed on emergency, or for convenience, are:—

S.S. "Innamincka"	2500	gross tonnage
,, "Adelaide"	1711	do.
,, "Bullarra"	1725	do.
,, "Victorian"	716.	do.
,, "Barrier"	2036	do.
,, "Albany"	878	do.
,, "Emu"	616	do.
,, "Flinders"	521	do.

Intercolonial Service.—Weekly.

Between Fremantle and Sydney, calling in either way at the intermediate ports of Adelaide and Melbourne.

The Intercolonial steamers call at Bunbury every fortnight.

Fremantle-Geraldton Service.—Weekly.

Calling in at Dongara.

Average duration of voyage, 24 hours.

Fremantle-Roebuck Bay Service.—Four-weekly.

Calling at Geraldton, Sharks Bay, Carnarvon, Ashburton, Cossack, and Pearling Grounds.

Derby and Wyndham.

Derby every 4 weeks, Wyndham every 8 weeks.

This service is carried out by the s.s. "Albany."

Passage Rates to Western Australia by the Vessels of the Adelaide Steamship Company.

	Saloon.		Steerage.	
	Single.	Return.	Single.	Return.
From Sydney to—	£. s. d.	£ s. d.	£ s. d.	£ s. d.
Albany	9 0 0	15 10 0	6 0 0	11 0 0
Fremantle	9 0 0	17 10 0	6 0 0	12 0 0
From Melbourne to—				
Albany	8 0 0	13 10 0	5 0 0	10 0 0
Fremantle	8 0 0	16 10 0	5 0 0	10 0 0
From Adelaide to—				
Albany	7 0 0	11 0 0	4 10 0	9 0 0
Fremantle	7 0 0	13 10 0	4 10 0	9 0 0

Freights vary according to competition.

Rates of Passage Money and Freights.

Ports.	Passengers.					Cargo.
	1st Class.	Return.	2nd Class.	Return.	Natives on Deck.	General.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	per ton 40 cubic feet. s. d.
Fremantle to						
Bunbury	1 1 0	1 11 6	0 15 0	1 2 6	..	12 6
Vasse	1 7 6	2 0 0	0 18 0	1 7 6	...	15 0
Albany	2 15 0	4 2 6	1 15 0	2 12 6	...	15 0
Fremantle to						
Dongara	2 10 0	4 0 0	1 10 0	2 10 0	0 15 0	15 0
Geraldton	2 10 0	4 0 0	1 10 0	2 10 0	0 15 0	15 0
Sharks Bay	5 0 0	8 0 0	3 0 0	4 14 0	1 10 0	27 6
Carnarvon	6 0 0	9 10 0	3 15 0	5 15 0	2 2 0	32 6
Ashburton	8 5 0	13 0 0	5 5 0	7 17 6	3 0 0	35 0
Cossack	9 9 0	15 0 0	6 5 0	9 9 0	3 15 0	35 0
Roebuck Bay ...	11 10 0	18 15 0	7 15 0	11 10 0	4 0 0	45 0
Derby	13 0 0	21 0 0	8 15 0	13 10 0	5 10 0	47 6
Wyndham	16 0 0	26 0 0	10 10 0	16 0 0	7 0 0	57 0

The Combined Service of the West Australian Steam Navigation Company, Limited, and the Ocean Steamship Company.

This Company has two first class vessels, the s.s. "Saladin," 1,498 tons net register (1,999 tons gross), and the s.s. "Australind," 553 tons net register (1,019 tons gross), which carry out a monthly service between Fremantle and Singapore, touching at the usual coast ports. This service will shortly be supplemented by the s.s. "Sultan," now being built, when the boats will run every three weeks. At Singapore they connect with Holt's Ocean Line of Steamers, which leave there for London, &c., about twice a week. All cargo is transhipped into steamers at Singapore, unless otherwise arranged for. The average duration of the voyage between Fremantle and Singapore is 20 days, and from Singapore to London 42 days.

Rates of Passage Money and Freights.

Ports.	Passengers.					Cargo.
	1st Class.	Return.	2nd Class.	Return.	Asiatics, &c., on deck.	General.
Fremantle to—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	per ton.
Geraldton	2 10 0	4 0 0	1 10 0	2 10 0	0 15 0	15/0
Sharks Bay	5 0 0	8 0 0	3 3 0	4 14 6	1 10 0	27/6
Carnarvon	6 0 0	9 10 0	3 15 0	5 15 0	2 2 0	32/6
Ashburton	8 0 0	13 0 0	5 5 0	7 17 0	3 0 0	35/0
Cossack	9 9 0	15 0 0	6 5 0	9 9 0	3 5 0	35/0
Roebuck Bay... ...	11 10 0	18 15 0	7 15 0	11 10 0	4 0 0	45/0
Derby	13 0 0	21 0 0	8 15 0	13 10 0	5 0 0	47/6
Java	18 0 0	30 0 0	12 0 0	20 0 0	7 0 0	...
Singapore	20 0 0	33 0 0	12 10 0	22 10 0	7 0 0	40/0
Calcutta, Madras, Bombay, Manilla, Colombo	33 0 0	60 0 0	19 0 0	35 0 0	10 0 0	60/0
Hong Kong	28 0 0	50 0 0	19 0 0	35 0 0	8 5 0	50/0
Shanghai	34 0 0	60 0 0	22 10 0	42 10 0	10 0 0	60/0
Japan	36 10 0	68 10 0	22 10 0	42 10 0	10 0 0	60/0
London, Marseilles, Havre, or Hamburg	45 0 0	80 0 0	25 0 0	46 0 0	...	45/0 to 50/0

Dalgety & Co., Limited, Agents

Huddart, Parker & Company, Limited.

This Company maintain a line of steamers running between Melbourne and Fremantle, and calling in, *en route*, at Adelaide, Albany, Vasse, and Bunbury.

The service is conducted at present by the under-mentioned vessels, or others, one of which leaves Melbourne about every three weeks:—

S.S. "Lindus"	...	1679 Gross Tonnage
S.S. "Wendouree"	..	1640 ,,
S.S. "Nemesis"	...	1393 ,,
S.S. "Tasmania"	...	2000 ,,

Passage Money.

From Melbourne to Fremantle, Saloon only	...	8	0	0
,, Adelaide ,, ,,	...	7	0	0
,, Albany ,, ,,	...	1	10	0
,, Vasse ,, ,,	...	1	0	0
,, Bunbury ,, ,,	...	0	15	0

This Company are now building new Steamers, specially adapted for the W.A. trade.

Dalgety & Co., Limited, Agents.

Messrs. Howard Smith & Sons.

At present the service is a combined one between the Australasian United Steam Navigation Co., Ltd., and Wm. Howard Smith & Sons, Ltd., despatching a steamer weekly from Sydney, Melbourne, and Adelaide, to Albany and Fremantle, and continuing to Geraldton when inducement offers. The steamers occupied in the service are:—

S.S. "Bulimba"	...	2513 Tons Gross
S.S. "Waroonga"	...	2513 ,,
S.S. "Cintra"	...	2000 ,,
S.S. "Gabo"	...	2000 ,,

The present rates of passage money, which are exceedingly low in consequence of the competition existing, are as follows:—

		Saloon. £ s. d.		Steerage. £ s. d.
From Sydney to Fremantle	...	8 0 0	...	5 0 0
,, Melbourne ,, ...	...	7 0 0	...	4 10 0
,, Adelaide ,, ...	...	6 10 0	...	4 0 0

Besides the above-named Steamship Companies, Messrs. McIlwraith, McEacharn, & Co. are now trading between the Eastern Colonies and Fremantle.

RAILWAYS.

The present Government Railway System of Western Australia consists of:—

1st. *The Eastern Railway*, from Fremantle, the chief Port of the Colony, through Perth to Guildford, York, and Beverley, where it joins the Great Southern Line to Albany; with branch lines from Spencer's Brook to Southern Cross, and Clackline to Newcastle.

2nd. *The Northern Railway*, from Geraldton to Northampton, 34 miles, with a branch to Walkaway $17\frac{1}{2}$ miles in length.

3rd. A line from *Perth to Bunbury*, 110 miles, and 25 miles on to Donnybrook.

All these lines are built 3 feet 6 inches wide, which is the normal gauge of the Colony, and belong to and are worked by the Government.

Great Southern Railway.

In addition to these Government Railways, an English company ("The West Australian Land Company, Limited") has constructed a line of Railway from Albany to Beverley, a distance of 242 miles, receiving a grant of 12,000 acres of land for every mile constructed, to be selected within a belt of 40 miles on either side of the line, but with half the frontage to the Railway reserved to the Government. The line was completed and was opened for traffic on the 1st of June, 1889.

Midland Railway.

This line of Railway is in course of construction. It starts from the junction with the Eastern Railway near Guildford and runs Northward, *viâ* Gingin, to Walkaway, where it joins the Government line "Geraldton-Walkaway Railway."

Two sections of this line have recently been completed and are open for traffic (1891), viz., from Guildford to the Moore River, a distance of 69 miles, and from Walkaway to Mingenew, on the Irwin River.

This Railway is being constructed under a concession on the land grant system, the Company receiving 12,000 acres for every mile of Railway. The total distance will be about 295 miles.

Albany-Torbay Railway.

Messrs. C. & E. Millar have also under a special concession constructed a line of Railway on the land grant system from a point on the Great Southern Railway (10 miles 17 chains from Albany) to Torbay, a distance of 12 miles. This line is now complete and open for traffic.

Darling Range Railway.

A special concession was obtained by Mr. E. Keane in 1891, and a line of 19 miles 62 chains has since been made from Guildford along the Darling Range, more particularly for the purpose of opening up a timber industry. The concession is now held by the Canning Jarrah Timber Co., Limited.

The Jarrahdale Railway.

Under a special timber concession agreement the Jarrahdale Timber Company have completed a line from Rockingham to their timber mills, a distance of over twenty miles, and from the mills inland.

In addition to these railways there are several private tramway lines belonging to Timber Companies in the South and South-Western parts of the Colony, which eventually may become a portion of the Railway System.

Cossack-Roebourne Tramway.

Cossack and Roebourne are joined by a Tramway, $8\frac{1}{2}$ miles in length, belonging to and worked by the Government. This line is built to the two-feet gauge.

Western Australia has now in working order 204 miles of Government Railways and 385 miles of private lines, or in all 589 miles open for traffic.

Lines under Survey.

The following lines are now being surveyed or constructed :—

- Eastern Railway Extension, from Northam to Yilgarn Goldfields, 164 miles.
- Geraldton to Mullewa Railway, 80 miles.
- Bunbury to the Vasse, about 30 miles.

POSTAL SERVICE.

English and Intercolonial Mail Service.

The English and Colonial Mails arrive and depart weekly. Since the end of January, 1888, when the fortnightly contract with the P. and O. Company expired, they have been brought to King George's Sound, alternately, by the steamers of the Peninsular and Oriental Company, and the Orient Company. The steamships of the Messageries-Maritimes Company, which are under contract with the French Government to convey a monthly mail between Marseilles and New Caledonia, also call in at the Sound, and generally carry a mail for this Colony. Special occasional Intercolonial Mails are, in addition, received and despatched by the vessels of the Adelaide S.S. Company, a line of which runs irregularly between Fremantle and Sydney. All outward mail steamers call in at Adelaide, where the mails are disembarked and conveyed to their destination by rail.

King George's Sound is the first and last Australian port of call of the large ocean-going mail steamers, but the day is probably not very far distant when the mail steamers will call at Fremantle (a point nearer to England than Albany) and land their mails, which will then be despatched by train to Adelaide. Proposals have already been made to the Government to construct a railway, upon the Land Grant System, from the Eastern Districts of the Colony to Eucla. When this work is accomplished, and South Australia has extended her railways to the same point, Perth will be connected with the capitals of all the other Australian Colonies.

European Mails.

The Outward Mails are due at King George's Sound on Saturdays, and the letters should reach Perth on the following Monday; this necessarily, however, is often changed, owing generally to the early arrival of the mail steamers, which are frequently four days in advance of their contract time. The time of their probable arrival is therefore always cabled from Colombo, and the closing of the mails for the colonies at the General Post Office, Perth, is time, so as just to leave time to catch the steamer. They only remain as a rule about six hours in King George's Sound before proceeding on their voyage.

The Homeward Mails close at Perth on Fridays, and are forwarded by special train to Albany, arriving the following morning in time to catch the mail steamer, which is due in King George's Sound every Saturday.

The mails to and fro between Beverley and Albany are conveyed by the Great Southern Railway, by special trains, once a week, each way.

A Travelling Post Office has been established on the Railway between Fremantle and Albany, by means of which foreign mails arriving at Albany are sorted before reaching Perth, thus enabling the General Post Office at Perth to make a delivery of the correspondence received from abroad within half-an-hour after the receipt of the mail.

Postage Rates.

Letters posted at any Post Office for persons residing within the limits of the delivery of such office:—½ oz., 1d.; 1 oz., 2d.; 2oz., 4d. Then 2d. per ½ oz., or fraction of an ounce.

Letters beyond such limits, but within the Colony: ½ oz., 2d.; 1 oz., 4d. Then 2d. per ½ oz. or fraction of ½ oz.

Intercolonial Letters.

½ oz., 2d.; 1 oz., 4d. Then 2d. per ½ oz. Registration fee, 4d.

United Kingdom.

½ oz., 2½d.; 1 oz., 5d. Then 2½d. per ½ oz., or fraction thereof. Registration fee, 3d.

Post Cards.

½d. Post Cards are delivered within town where posted; 1d. ones elsewhere in the Colony, and Eastern Colonies, Queensland excepted; 2d. Post Cards for United Kingdom, *viâ* Brindisi or Naples.

Newspapers.

Western Australian papers posted within seven days of publication, free within the Colony.

Do. posted afterwards	... ...	1d.
Do. „ to Eastern Colonies	... ...	½d.
Do. „ to United Kingdom	... ...	1d. for first 4oz. ½d. for each additional 2oz.

Packets and Parcels.

Inland:—2 oz., 1d.; 4 oz., 2d. Then 2d. every 4 oz., or fraction thereof. United Kingdom:—1 oz., 1d.; 1 to 2 oz., 2d.; 2 to 4 oz., 4d.; 4 to 8 oz., 8d.; 8 to 12 oz., 1s.; 12 to 16 oz., 1s. 4d.

Parcel Post.

There is no Inland Parcel Post.

English and Intercolonial.

There is at present no Parcel Post exchange established between New South Wales or Queensland and this Colony.

Victoria South Australia Tasmania	2lbs. or under, 1s. 2d. Each additional lb., 7d.
New Zealand United Kingdom	2lbs. or under, 1s. 6d. Each additional lb., 9d.

Parcels must be limited in weight to 11 lbs., and in size must not exceed 3 feet 6 inches in length, or 6 feet in girth and length combined.

Money Orders.

There are thirty Money Order Offices established in Western Australia.

Rates of Commission.

	Any sum not exceeding			
	£2	£5	£7	£10
Inland	3d.	6d.	9d.	1s.
Intercolonial	...	1s.	...	2s.
United Kingdom, India, Singapore, Hong Kong, Mauritius	1s.	2s.	3s.	4s.

Postal Notes.

Postal Notes have been in use in this Colony since June, 1887. They are only negotiable within the boundaries of the Colony, where they are payable to bearer, or, if crossed, to the lawful endorser, at nearly all the principal Post Offices, if presented within the usual office hours.

TELEGRAPHS.

The first telegraph line constructed in the Colony was that between Perth and Fremantle (a distance of exactly twelve miles) which was constructed by a private company, and opened for traffic on the 21st June, 1869. This line was taken over by the Government during April, 1871.

The following are the principal lines which have since been constructed:—

Perth to Jarrahdale, Pinjarrah, Bunbury, Vasse, Bridgetown, and Greenbushes.
„ „ Albany, Eucla, and the Colonies.
„ „ Newcastle, Northam, Beverley, York, Southern Cross, Pingelly, Wagin, Narrogin, Katanning, and Broomehill.
„ „ Gingin.
„ „ Fremantle.
„ „ Geraldton, Northampton, Carnarvon, Roebourne, Cossack, Broome, Derby, Hall's Creek, and Wyndham.

Roebuck Bay is the station where the alternative cable of the Eastern Extension Telegraph Cable Company from Banjowangie is landed, and is 2,491 miles from Eucla.

Wyndham, the Northern limit of the Western Australian telegraphic system, is $3{,}131\frac{1}{4}$ miles from Eucla, the Southern limit.

Cable communication is now available from Western Australia to Europe, either direct by Roebuck Bay or *viâ* Adelaide and Port Darwin.

Telegraphic.

Office hours, 8 a.m. to 7 p.m.; *Sundays and Holidays*, 8 to 9 a.m., and 6 to 7 p.m.

Telegraphic messages are forwarded to any station in the following parts of the world at the rates specified, no charge being made for signature and address, except where specially noted:—

Western Australia:

	s.	d.
Ten words { Between Perth and Fremantle	0	6
Ten words { Country offices	1	0
Extra words ... ... each	0	1
Press Rates.		
Ten words and under	0	6
Thence rising by ½d per word to 1s. 6d., which covers 100 words		
Each additional 50 words or under	0	6
New South Wales:		
Ten words, 3s.; extra words ... ... each	0	3
Victoria:		
Ten words, 3s.; extra words ... ... each	0	3
Queensland:		
Ten words, 4s.; extra words ... ... each	0	4
South Australia—Port Darwin line excepted:		
Ten words, 2s.; extra words	0	2
Press Rates.		
16 to 100 words	3	0
Every additional 50 words	1	6

		s.	d.
TASMANIA:			
Ten words, 4s.; extra words	each	0	4

(Address and signature, ten words only, sent free).

NEW ZEALAND:			
Ten words, 9s. 6d.; extra words	each	0	11

Address and Signature charged for.

EUROPE:			
Each word		4	9

Address and Signature charged for.

On special occasions, when the communication may be kept open after office hours, and on Sundays, double the ordinary rate will be required upon all Messages.

Messages may be transmitted in *cypher* in the English language on payment of *an additional charge of fifty per cent., but cypher words must not average more than two syllables.*

By Authority: RICHARD PETHER, Government Printer, Perth.