the case in other mining centres is clearly proved in the Coolgardie Goldfield, *e.g.*, the outputs of the Great Hanover and Rose Hill Gold Mines, which are both situated at or near felsitic dykes,* and from which plentiful supplies of water are obtained.

The Mines.

As stated in a previous part of this Report, I was unable to make any personal observations of the workings (underground) of the mines, owing to the leases having been abandoned, or work being suspended pending exemption. The notes which have been made of the surface workings are practically useless; it is therefore unnecessary to include them in this place.

BORING FOR WATER AT HAYES' NEW FIND.

Accompanying this report are a geological map (Plate III.) and section, which I have made in order to illustrate, approximately, the general geological features and boundaries of that part of the Hayes' New Find district, under special notice, and to show the exact location of the two Government bores, and all underground workings, which have been carried to a depth below the water level. In addition, the surface plan shows the location of typical rock specimens and samples of water, which have been collected. In the section, the relation of the different rocks to one another, their approximate thickness and dip may be seen.

Location of Hayes' New Find.

Hayes' New Find lies in the North-East Coolgardie Goldfield, at a distance of 24 miles North by East from Kanowna, and about 30 miles due East from Bardoc.

General Description of the Hayes' New Find and surrounding Districts.

The contour of the country lying within a radius of 30 miles of Hayes' New Find townsite, is extremely flat, broken only by small isolated ridges, and an occasional higher point, such as Mount Jewel, which lies four miles to the North of Mulgarrie. From these slightly elevated portions, the drainage of the country, in times of rain, falls into the shallow depressions, known either as lakes or clay pans, according to their size. When such depressions are filled with water, they do not remain long in that condition, as the evaporation is very high, and the amount of water usually limited. In consequence, most of these natural reservoirs are covered with a coating of mixed salts, principally sodium and magnesium, which salts are usually in sufficient quantity to render the water salt or brackish, even immediately after a rainfall. The country immediately surrounding Hayes' New Find forms the centre of a watershed for several of these so-called lakes, which lie more particularly to the South, South-East, and North, and at a distance of several miles. Within the radius above-mentioned the geological features are almost monotonous, and unvaried as the topographical. With the exception of occasional outcrops on the higher portions, the whole of this country is covered over with a recent superficial deposit, usually of a red colour, and more or less sandy. This deposit is evidently the detritus of the basic rocks, the sand grains being derived from the intruding porphyry dykes.

Geology of Hayes' New Find.

As in the surrounding districts, much of this field is covered with the mantle of red alluvium, though to the North, North-West, and West of the townsite, several extensive outcrops of the underlying rocks may be seen. Such outcrops are found to consist chiefly of belts of quartz porphyry, intruding (?) schists, which are much weathered at the surface. Intruding the porphyry itself, several smaller dykes of rock of a more basic character may be seen; and though the outcrops of these basic dykes are too much altered to enable one to definitely classify them, there is sufficient evidence to show that they are of a different age and nature to the rocks enclosing them. The porphyry is found on examination to consist of a felsitic base, impregnated with crystals of quartz and felspar. Usually, only the decomposed products of this rock are found at the surface, and as such, the whole of the felspar and felsitic base are found decomposed into kaolin, in which are the blebs of quartz. Fragments of the unaltered rock are, however, sometimes met with at the surface, and show the true nature of the rock.

In the weathered portions of the porphyry an apparent cleavage is often visible, this structure arising, no doubt, from lateral pressure and subsequent weathering. The strike of this cleavage is identical with that of the surrounding rocks, viz., North 15 degrees to 20 degrees West, and South 15 degrees to 20 degrees East.

In describing the schists little can be said at present with any degree of accuracy, as in only two cases which came under my notice had the undecomposed zone been pierced. On the Bulletin Gold Mine (G.M.L. 624x) and the Golden Puzzle Gold Mine (G.M.L. 2940x) as far as could be ascertained from inquiry and examination of the rock on the dumps of the shafts, serpentine schists was passed through, and these had gradually become harder and more compact till at length a rock devoid of schistose structure was encountered. This alteration was complete at the 200ft. level (approximately). I have little doubt, therefore, that similar conditions prevail on this field with reference to these rocks, as in the Coolgardie Goldfield, *i.e.*, that the schistose structure is due only to the weathering of the surface of basic rocks such as diorites, etc., and that there is no probability of the schists being of sedimentary origin. The prevailing strike of the schists is North 15 degrees to 20 degrees West. Capping the higher portions of the schists and porphyry are the remnants of former sedimentary beds of sandstone and ironstone gravels. Of the sandstones there are two classes, a hard compact variety changed to quartzite, and resembling the quartzites capping the higher grounds on the Murchison Goldfield; a soft sandy variety known locally as cement, resembling the cements of Kanowna. Both of these deposits are non-auriferous and very limited in extent.

* *Vide* Annual Progress Report of the Geological Survey for the year 1897. Perth: By Authority, 1898, also Bulletin No. 3. The Geology of the Coolgardie Goldfield, by T. Blatchford. Page 44.

The ironstone gravel deposits are similar in nature and habit to those found in the Coolgardie district.

The Water Supply of Hayes' New Find.

So far as could be ascertained the water level had been reached, in the vicinity of Hayes' New Find, in seven cases only:—

Name of Mine.	G.M.L.	Vertical depth of water level below surface.	Output of Water in gallons per 24 hours.	Nature of Water.
		feet.		
South Gippsland No. 3	2,523x	180	11,000	Salt
Cosmos	508x	160	(?)	Salt
Homeward Bound	516x	190	1,000	Salt
Golden	2,940x	190	2,000	Salt
Water Reserve at Lindsay's ...	...	180	300	Fit for stock only
Government Bore No. 1	...	...	...	...
Government Bore No. 2	...	...	...	...

It will be noticed from the accompanying plan (Plate III.) that all the above have been sunk on schist with the exception of Government Bore No. 1 (on porphyry), and the shaft on the Water Reserve at Lindsay's (on diorite?).

With reference to the shafts on the mining properties above enumerated, details as regards the water supply are unavailable, except in the cases of the South Gippsland Gold Mine No. 3, and the Golden Puzzle Gold Mine, as work on the other mines is for the time suspended.

In the South Gippsland No. 3, water was struck at the 180ft. level, and continued to flow into the shaft till the 200ft. level was reached, when the influx of water ceased, the latter condition prevailing to the 240ft. level, when sinking was discontinued. The rock passed through was serpentine schist to about the 200ft. level, but below this level the schist changed into hard compact rock (probably diorite), which was impervious to water.

The water shaft in the Golden Puzzle Gold Mine has been struck to a vertical depth of 230ft. Water was not met with until the 220ft. level was reached, though the water afterwards rose to the 190ft. level. Below the 220ft. level the country rock became hard and compact, but easily mined on account of its broken nature, which no doubt accounts for the presence of water. The influx of water however decreased at the lowest level.

Taking these two examples as they stand there is strong evidence that the water (1) is surface soakage water; (2) that this soakage cannot extend below a vertical depth not exceeding 250 feet from the surface; (3) that the supply of water is limited.

On the water reserve at Lindsay's a shaft has been sunk to a depth of 180 feet. The water supply is about 300 gallons per diem. This supply is found to vary with the rainfall, and is fit for stock.

The limited supply of water is what might be expected for any part of the field inasmuch as this part of the country forms the higher ground of the district under notice, and consequently does not receive the full advantage of the surface soakage resulting from the periodic rains.

The following are two analyses made by Mr. Simpson in the official laboratory of samples of water typical of the district:—

	1339* Water Reserve at Lindsay's.	1336* South Gippsland, Vosperton.
Sodium Iodide, NaI	Slight trace	...
Sodium Bromide, NaBr	...	Trace
Potassium Chloride, KCl	...	·0547
Sodium Chloride, NaCl	·4398	3·0018
Magnesium Chloride, $MgCl_2$	...	·3027
Potassium Sulphate, K_2SO_4	Trace	...
Sodium Sulphate, Na_2SO_4	·0887	...
Magnesium Sulphate, $MgSO_4$	·0216	·2512
Calcium Sulphate, $CaSO_4$	...	·1598
Sodium Carbonate, $NaHCO_3$	...	...
Magnesium Bicarbonate, $MgH_2(CO_3)_2$	·0555	...
Calcium Bicarbonate, $CaH_2(CO_3)_2$	·0230	·0393
Ferrous Bicarbonate, $FeH_2(CO_3)_2$	...	·0008
Sodium Nitrate, $NaNO_3$	...	Slight trace
Silica, SiO_2	·0003	·0037
Sodium Silicate, Na_2SiO_3	...	...
Alumina, Al_2O_3	...	·0079
Total	·6289	3·8219
Re-action	Alkaline	Alkaline
Specific gravity	1·0051	1·0284

* These numbers refer to laboratory numbers of the Department.

With reference to artesian water, there is no single condition in favour of its occurrence, and, in my opinion, it would be useless to attempt boring with such an object in view. If boring be attempted I would recommend that the site be chosen on the flats lying to the South of the townsite, as a considerable amount of the drainage from the higher grounds pass over this portion of the field, though I feel convinced that after the oxidised zone be passed through, hard compact impervious rock will be met with, at a depth not exceeding 250 feet, and that such a condition will continue to an indefinite depth. *

THE GEOLOGY OF THE BARDOC DISTRICT.

Location.

The Bardoc Mining District embraces the most Northern of the four groups of mines in the Broad Arrow Goldfield, and lies in the neighbourhood of the township of Bardoc. Direct railway communication connects Bardoc with Fremantle, from which it is distant about 419 miles.

History.

Unfortunately little if anything is recorded directly about the early history of the Bardoc Mining District. In the History of Western Australia,† brief reference is made to a "rush" to Broad Arrow (Kurawa) and Black Flag in the early part of the year 1894, and I have reason to believe, from verbal information, that shortly afterwards prospectors discovered gold in the vicinity of the townsite of Bardoc. No direct reference, however, is made to the exact locality in which the discovery took place.

General Description.

The district which has been mapped in detail, and depicted on a plan (Plate IV.), embraces an area of about 40 square miles. The topographical features displayed over this area are exactly similar in nature to such mining centres as Hayes' New Find, Hayes' Find (Mulgarrie), etc., and consist of low lying sparsely timbered country, the monotony of which is broken only by occasional isolated knolls and ridges.

General Geological Features.

The general geological features resemble closely those of the Coolgardie goldfield, underlying a superficial covering of red superficial deposits, the *débris* of the country rock disintegrated *in situ*, occur massive hornblende rocks intersected with acid eruptive dykes, which in all probability emanate from the massive granite found outcropping at the Eastern and North-Eastern boundaries of the field. Running parallel to these dykes, which have a prevailing North and South strike, persistent lines of quartz reefs occur. These reefs can easily be classified into two varieties, viz., those consisting of almost pure white quartz, and those the quartz of which is often more or less regularly banded with oxides of iron. The latter variety resembles very much at times the banded quartzites found in the Murchison and East Murchison goldfields.‡ Overlying parts of the field are the nodular ironstone beds which form a prevailing surface feature of such a large portion of the Colony of Western Australia.

Superficial Deposits.—The superficial deposits of the field consist of two distinct formations, viz., the loose incoherent material and the nodular ironstone beds. Shallow superficial deposits of partially classified *débris* of the surrounding rocks cover the greater portion of the field. These deposits consist for the main part of ironstone pebbles, the denuded fragments of the nodular ironstone beds intermixed and cemented together with the kaolinised decomposition products of the hornblende rocks and granites. For a few feet from the surface such deposits are usually soft, but become much harder at a greater depth, the infiltrating iron cementing the whole mass into a more or less compact conglomerate. Several attempts have been made in the way of prospecting for gold at the lower levels of these deposits, but up to the present these have proved futile, though there is no reason why gold should not be found in payable quantities. The great disadvantage, however, in prospecting beds of this class is the difficulty in finding any indication at the surface of the contour of the bed rock, a fact which necessitates prospecting being carried on at a great expense and in a haphazard way. Dating back to the discovery of the field alluvial gold was sought for and won in considerable quantities, more especially in the immediate vicinity of the "Bardoc Hill." The amount of gold gained from this source cannot be ascertained, as records of it have not been kept officially, and the original prospectors have long since left the locality. All the gold obtained from this source was won either by "specking," *i.e.*, picking out the larger pieces as they were seen in the loose *débris*, or by the process of gold recovery known as "dry blowing."§

Nodular Ironstone Beds.—In the Bardoc District these deposits are usually to be found covering the higher ground for which they form protecting caps, which resist the power of denuding agencies. In many instances it is impossible, with the present mining developments, to investigate the nature of these deposits. There is, however, one place in particular where one of the ironstone cappings has been apparently prospected in mistake for an ironstone lode. On Gold Mining Lease 512E two adits have been driven in the side of the hill at a depth from the surface where the ironstone is gradually merging into the underlying basic rock. It is evident in this section that the iron oxides from the basic rock-forming minerals, are in process of segregation and are gradually replacing the less basic constituents. That such a process is the cause of some of the ironstone deposits is further borne out in such sections as may sometimes be seen in the railway cuttings, *e.g.*, Coates Siding,‖ where the percentage of oxide of iron is much higher at the surface than at a greater depth of but a few inches. The evidence of the section at

* Water may be carried far below this depth by means of fissures, to search for such, however, is practically useless. A.G.M., G.G.

†History of Western Australia. W.P. Kimberley.

‡Annual Progress Report of the Geological Survey for 1897. Perth: By Authority, p. 20.

§ Vide Annual Progress Report of the Geological Survey of Western Australia for the year 1897. Perth: By authority, 1898. Report on the Coolgardie Goldfield, p. 56.

‖ Coates Siding is a small railway platform on the railway line crossing the Darling Range.