

The main formation which runs through the Mystery and adjoining leases consists chiefly, in the oxidised zone, of kaolinic material, and is of considerable width; it contains numerous veins and stringers of quartz, striking across the lode, which generally carry values. There is also a series of flat tourmaline-bearing quartz veins which as a whole, are non-auriferous. Stringers and lenses of ironstone are common in the oxidised zone. It is possible that much of the gold in the upper levels is of secondary origin.

The Kapai or eastern line of lode is closely associated with one of those haematite-quartz rocks generally known as "jasper bars" which are so common on these goldfields.

But little gold is found in the haematite-quartz rock itself, the best values being obtained from cross leaders of quartz running roughly at right angles to the "jasper," and also in kaolinic material on the walls of the latter generally on the Western side.

As in the case with the Mystery line of lode, the Kapai line appears to owe much of its gold contents in the oxidised zone to secondary concentration, and neither appear to present the same possibilities at depth as the Western line.

The fieldwork in connection with the second section of the work was commenced on the 8th August. This section will complete the detailed examination of the North End of the field. Since the above date, my attention has been mainly devoted to the mapping of surface features generally.

This portion of the work was completed early in December, and the examination of the underground workings was then commenced.

The Country between Kalgoorlie and Coolgardie.

With the object of linking up mining centres, Mr. Honman mapped, in a more or less broad way, an area between these two centres, and brought several important facts to light. This officer summarises his work in the preliminary report which is as follows:—

A—Binduli mapped in detail, comprises an area of 16 square miles, extending two miles north of Binduli Railway Station, and three miles south of the same, and in an easterly and westerly direction from the Kurrawang conglomerate ridge, to within four miles of Kalgoorlie. Mr. C. G. Gibson, a former officer of the Survey, has already mapped the area in a broad way, and his classification of the rock areas is entirely confirmed by the detail work done last year. Mr. Gibson divided the rocks into two groups, viz.:—Porphyries and Sedimentaries. The Sedimentary Rocks occupy a considerable area of the country under review, about eight square miles. The topographical features compose a conglomerate ridge bearing 340° and running across the Coolgardie road at 16 miles 30 chains from Coolgardie, also a ridge of massive porphyry and schists bearing 325° to 330° crossing the railway line near the Binduli Railway Station. The general slope of the country is to the South where it terminates in breakaways and salt lakes. Two miles north of the Railway Station the country attains its highest elevation, and is very sandy; it falls very gradually northwards for many miles, and culminates in salt lake country; it consists of sand covered with mallee and spinifex.

The office work is not as yet far enough advanced for the formation of any final conclusions as regards the geological structure and history of the area, but the following features are brought out by the field work:—

The strike of the bedding planes does not necessarily coincide with the strike of the schistosity or cleavage.

The presence of conglomerate schists and slates in the porphyry area. The slates are apparently interbedded with the schistose porphyry.

The sedimentaries outside and west of the porphyritic area have a consistent dip to the west at a high angle, which becomes more pronounced in a westerly direction.

The conglomerate formation is persistent right across the area and the conglomerate series is at least half a mile thick.

There are two systems of fissuring in which quartz veins have formed:—

- (a.) Vertical coinciding with shear and cleavage planes caused by pressure at right angles to the strike of the cleavage.
- (b.) Flat, though with a slight southerly; the fissures are small and discontinuous.

The quartz veins occur both in the schists and the massive porphyry. In both they have been found to carry gold which from report averages about 10dwts. to the ton, but the veins are small and the porphyry is too hard to enable them to be worked profitably.

B.—An area between Coolgardie and Kalgoorlie.—This comprises 350 square miles and has been mapped broadly with the object of bringing out the structural relations of the different rocks.

The topographical features are controlled by the geological formations. The greenstone areas which occupy about 100 square miles are characterised by hilly country composed of long rugged hills with their longer axes coinciding with the dominant strike of the rocks which varies from 300 deg. to 340 deg. The granite and porphyry areas compose prominent rises characterised by flat-topped bosses of granite and porphyry. The sedimentary rocks with the exception of the conglomerate and quartzite occupy the depressions and flanks of the ridges. The conglomerates north of the lake which stretches from near Boulder towards Coolgardie form two well defined parallel ridges which are two miles apart and represent the eastern and western legs of the huge syncline. These encroach on the lake country which extends for about 14 miles in a south-westerly direction from M.H.L. 47E to within 7 miles of Coolgardie. This lake is separated from Hannans Lake by a prominent greenstone ridge and it is three miles wide in places. The northern margin of the lake is bounded by breakaways which in places exhibit excellent geological sections, while the southern edge is composed of sandhills and a white powdery deposit locally known as "Copi." The area comprises four main groups of rocks:—Sedimentary, Greenstone, Porphyry, and Granite.

No opportunity has yet occurred of definitely working out the relative ages of the respective rock groups, but when the necessary office work is more advanced the facts observed in the field can be properly studied and correlated. At the present stage the following statements can be provisionally made:—

An important syncline exists between Coolgardie and Kalgoorlie about 8 miles wide, the axis of which is very close to the Kurrawang Railway Station. The syncline has a strike of 340 deg. and if anything pitches very slightly to the North. The presence of this syncline suggests that the country is composed of big folds whose bedding planes have been destroyed by great lateral pressures producing schistosity and cleavage.

The Binduli porphyries persist with an almost uniform width for 24 miles passing through Wongi and are associated with sedimentary beds.

The conglomerates can be followed for over 15 miles along their strike.

Where the porphyries abut the greenstone rocks to the east they contain large phenocrysts of orthoclase which weather out in perfect crystals up to 1½ inches long.

Greenstone bands occur in the sedimentary rocks close to Mungari Railway Station, which make into a larger greenstone formation to the South striking 340 deg. and becoming wider while connecting with the greenstone area of which Mt. Herbert and Mt. Marion form prominent hills in the Hampton Lands and Railway Syndicate's Location 53.

Granite is intrusive into the sedimentary series and has transmuted those in close proximity into micaceous and chistolite schists. This has given the Coolgardie rocks a strike bearing more to the west of north than the main sedimentary area. It is probably to this intrusion that the highly metamorphosed state of the sedimentary rocks and the great abundance of tourmaline in the whole area is primarily due.

A greenstone area occurs at the western end of Location 53 and is probably continuous with that at Coolgardie.

A study of the conglomerates in the field shows conclusively that the bedding of the rocks is independent of the schistosity or cleavage, the elongation of the pebbles corresponding with the latter.

The whole area is intensely metamorphosed resulting from lateral pressure exerted in an easterly and westerly direction, and accentuated, if not actually caused, by the granite intrusions at the 8-Mile on the Coolgardie Road and at the Water Reserve 2956 in Location 53.

Petrological Work.

A brief synopsis of the results of the Petrologist's work during the year is given in his own words below:—

Most of the results of the year's work in detail either are now in the press or have already been issued in Bulletin form. Little more, therefore, is called for in these pages than a brief statement of the broad facts elicited in the examination of the rocks from the various districts. The more important localities from which specimens have been collected during the year are as follows:—

- The North Coolgardie and East Murchison Goldfields.
- The Kanowna Main Reef Line.
- The North End Kalgoorlie Field.

Ora Banda.
Coolgardie, Mount Monger, and Gibraltar.
Marble Bar.
The Binduli and Kalgoorlie Area of Mr. Honman.
Southern Cross.
The Oroya Black Range Gold Mine.

North Coolgardie and East Murchison Fields.—The majority of the rocks from this district, as described in Bulletin 45, are epidiorites or amphibolites of which, while some bear no trace of original structure, others indicate clearly from the presence of ophitic structure, an igneous origin from doleritic or gabbroid rocks. Since the absence of definite structure in some hornblende rocks is common in areas that have undergone strong dynamic metamorphism, it is probable that all described are of igneous origin.

For economic reasons, these outcrops deserve careful prospecting, for consideration of many other fields in the State has shown that auriferous formations occur both as quartz reefs in amphibolite or more altered rock and as lodes in the altered zones near the contact of the greenstones with, commonly, the granite.

There occur also a somewhat sugary quartzite, a ferruginous quartzite without banding and a mica schist. To these, though the elastic structures have not been certainly identified and the field evidence of the relationships of the rocks is necessarily small, it is probable that a sedimentary origin is to be assigned. A serpentine with silvery biotite has also been described from the district (see Bull. 45).

Kanowna Main Reef Line.—As will be seen by reference to Bulletin 47 already published, the rocks of this area are of several kinds:—(a.) Greenstones that have all been more or less completely altered chemically and probable dynamically with the production of talc, chlorite, sericite, magnetite, quartz, and ferrous and other carbonates. In most cases the alteration has proceeded to such a degree that all traces of original structures have been obliterated. The secondary minerals, however, which usually include talc, chlorite, ferrous carbonate, some iron ores and brown-yellow rutile suggest an origin from basic igneous rocks.

The green fuchsite-magnesite-quartz rock that I have already described from Meekatharra is well developed in the area, but, as before, there is not sufficient evidence to enable any definite pronouncement to be made as to its origin. It is noteworthy, however, that recently at Meekatharra in the Ingliston Extended Mine a white quartz reef is being worked at a profit in this rock.

(b.) The dyke rocks.—These include quartz-porphyrics of slightly differing varieties and an albite-porphyrite. Of the former some are fresh, others to a greater or less extent carbonated, and in some cases so altered as to possess but few original structural characters. Evidence of earth-movements over the area subsequent to the consolidation of the rocks is afforded by striated and slickensided surfaces on the specimens, by undulose extinction and cracks in individual crystals. Especially worthy of mention are two specimens with xenolithic enclosures; both are more or less normal quartz-porphyrics, one with an enclosure of a green chromiferous schist-illustrated in Bulletin 47, page 40—the other with small patches of greenish chloritic material which proves to be closely similar in structure and composition to the albite porphyrite that occurs in the field. There is another specimen with soft greenish spots, the origin of which is fully discussed in the text of the Bulletin.

The albite-porphyrite has been described from this field for the first time.

(c.) There are a number of rocks not classified on account of the impossibility of obtaining even relict structures. Further information with regard to these will be found in Bulletin 47.

North-East Kalgoorlie.—The importance of the survey of this area, lies in the fact that there is being gained in a less altered portion of the Kalgoorlie field information that must be of great value when the more chemically and mineralogically altered portions come to be considered. As shown in Bulletin 51, the main points which have emerged from an investigation of this area are these:—

The earliest rocks, and those that form the greater portion of the area, are greenstones, which comprise masses of doleritic or gabbroid type, others of amphibolite without doubt derived by extreme dynamic metamorphic action either from the former or from similar rocks, and talc-chlorite rocks which probably represent the extreme phase of chemical and dynamic alteration both of the dolerite and of the amphibolite. The movements which contributed to the production of the hornblende of the amphibolite from the augite of the dolerites or gabbros not only produced a shearing in the rocks themselves, but developed actual fissures in the rock masses in two series at right angles. Along several lines, moreover, the shearing and crushing stresses were probably greater than along others, with the result that distinct lines of weakness were produced in the rocks.

At a later date, along these lines and various fissures in the mass, there were intrusions of a highly acid dyke rock rich in soda and with frequent hornblende phenocrysts—on albite-porphyrite or quartz-keratophyre. A peculiar feature of the latter is that it possesses in places distinct xenolithic enclosures of chloritic schists, between which and the enclosing rock there does not appear to have been any sensible assimilative action.

Accompanying the acid intrusive were boric vapours which not only caused the production of tourmaline in the keratophyre and in the quartz leaders, but which in association with other gasses exerted a pneumatolytic action on the surrounding rocks.

There is evidence of distinct secondary enrichment in the lodes, a feature which, however, Mr. Feldtmann has enlarged upon in the Bulletin on the area.

Ora Banda.—From such an examination has as already been made of the rocks from this locality, the main types prove to be:—Serpentine, a fresh hypersthene-gabbro or norite, hornblende, amphibolised dolerite, zoisitised dolerite or gabbro and the so-called "native cat" rock. This latter has a green, rather fine-grained base with irregular yellowish white patches composed of granular epidote, zoisite, and some clear albite. The rock has a porphyritic appearance and has been put down as a saussuritized gabbro. That there is a true porphyritic facies, however, I discovered recently when examining a dump on the mine. There I obtained specimens, the counterparts of which had not been forwarded by the Field Geologist. These showed large dark-coloured fairly fresh idiomorphic feldspars in a ground-mass of epidote, calcite, chlorite, etc. In most cases the feldspars were in process of decomposition to epidote and other minerals. The rock may, therefore, be put down as a saussuritized gabbro-porphyrite. The amphibolised dolerite is identical with that from the North End Kalgoorlie.

Some secondary silicification appears to have taken place in the area, for specimens have been obtained of brown quartz and chalcedonic silica enclosing greenish chromiferous chlorite.

Marble Bar.—These specimens consisted chiefly of serpentine and opal serpentine.

Coolgardie, Mount Monger, and Gibraltar.—A large number of rocks were collected from these localities. The specimens include amphibolite, garnet, and biotite-amphibolite, hornblende-schist, hornblende, epidiorite gabbro, norite, hornblende gneisses, granite, aplite and pegmatite, quartz-porphyrics and porphyrites, mica gneiss, graphitic schist, sericite schist and banded ferruginous schist.

The amphibolitic varieties are essentially similar to those that have been described in the Bulletin on Southern Cross. The granites vary from the normal yellowish-grey type, through hornblende granite to gneissose hornblende-granite, and in the normal type veins of aplitic and pegmatitic modifications appear to be not uncommon. The gabbroid or doleritic rocks include a saussuritized amphibole micropegmatitic quartz dolerite, a saussuritized quartz gabbro and an ophitic quartz dolerite, some specimens being identical again with the amphibolised quartz dolerite from the North End Kalgoorlie and other places.

A fresh norite occurs in dykes, exactly similar to that described from Cue, from Ora Banda, and from other localities in the State. The porphyritic rocks comprise quartz-porphyrics of several varieties, and some specimens of more basic composition with silica slightly under and slightly over 60 per cent., which have been put down as quartz-porphyrics.

One porphyry specimen is closely akin to Spurr's alaskite, described from the Yukon district in Alaska, and, as in many places, this alaskite is gold-bearing, being one of the final stages in the development of gold-quartz veins from granitic rocks, it may repay the attention of prospectors.

There are some examples of schistose or foliated rocks—discussed in the Bulletin on the district—which may possibly be of sedimentary origin derived by consolidation and foliation from arkoses, siliceous sediments, and basic detrital material.

Binduli, etc.—The collection so far examined from Binduli and the vicinity, consists mostly of the following groups of rocks:—(a) acid porphyries generally pinkish in colour, and varying from felsites with felspar phenocrysts to rocks which agree in character with granite porphyries; (b) basic rocks of doleritic type; (c) a peculiar group of highly schistose green rocks, mostly altered to a considerable extent. In certain cases—of the more highly schistose and altered varieties—these latter specimens are practically indistinguishable from altered sheared porphyrites, but in one specimen, the characters are entirely consistent with the origin from a quartzose-felspathic-chloritic sediment that has been very considerably sheared. The felspar shapes are mostly angular, the quartz crystals are partly angular and partly rounded, frequently cracked. When account is taken of the fact that Mr. Honman has proved the presence in the

area of large developments of conglomeratic beds, of contact altered sediments now represented by chialstolite schists, mica schists, etc., there is no room for doubt that this specimen is a much sheared arkose or fine-grained chloritic conglomerate. It is highly probable, also, that the other very similar green schists are but more severely altered phases of the same rock.

One important feature of the felsitic pink porphyry of group (a) is the fact that there occurs a sheared sericitised modification of it, in many respects almost identical with the so-called "fish rock" of the Golden Mile. It will be remembered that Card, in a careful study of some of the Kalgoolie specimens, came to the conclusion that one of the original rocks of the field was an acid intrusive, and I am at present strongly of the opinion that this pinkish porphyry with few quartz phenocrysts is the rock which, passing through the sheared sericitised phase in which original structure is fairly plain, appears as the sericite-quartz-carbonate rock of the Golden Mile.

Southern Cross.—The oldest series of rocks in this field appear to be hornblende schists, etc., and the sedimentary rocks near Hope's Hill. Whether the latter are younger or older than the former, there is at present no means of discovering, but there is a presumption in favour of the younger age.

Before the movements took place, which affected the greenstones, there was an acid intrusion into the latter represented now by small foliated quartz porphyry dykes. Then came a large batholithic intrusion of granite which probably caused the contact metamorphism of some sediments with the production of garnetiferous phyllite and mica schist. Great movement then seems to have taken place in the

greenstone area and the effect of it extended some distance into the granite mass. Apophyses of the granite penetrated the greenstones with the production of pegmatite dykes, and granitic quartz reefs. The granite is the normal yellowish-gray biotite microcline granite, seemingly similar to the old Granite of South Africa. There is indubitable evidence that most, if not all the greenstones are but modifications by pressure and heat of rocks of doleritic and gabbroid origin, and though St. Smith makes two series of greenstones, the the Older and the Newer, the latter may be merely a zone of the older series that has been less strongly affected by dynamic action. An origin of one or two of the specimens of the older series from volcanic ashes is at least possible.

The auriferous reefs are found mostly in the schistose or older greenstones, the pegmatitic and quartzose apophyses of the granite being non-auriferous. The area is dealt with fully in Bulletin 49.

Oroya Black Range.—The examination from specimens from this district has been worthy of note owing to the proof obtained of the existence of a doleritic basalt with andesitic and glassy phases at Sandstone, identical with that in the Great Fingall Mine at Day Down. The rock occurs in each case as a dyke, and is probably the youngest rock in the field, being younger even than the lode formation.

I have, etc.,



Government Geologist.